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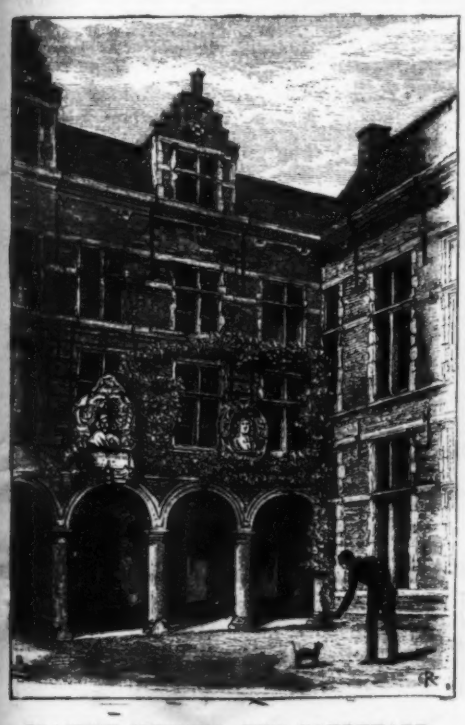
THE PLANTIN MUSEUM, ANTWERP.

Although printing, according to Mr. William Morris, is not an essential art, it is an essentially interesting one; and, seeing the part it has played in the fixing of our language, with its consequential influence on our character, the origin of the art must always possess an interest to Englishmen. Although he had no hand in the invention of printing, Christopher Plantin was one of the most famous fathers of the art; and it was his remarkable destiny to establish a printing office which endured to within a few years of the present time.

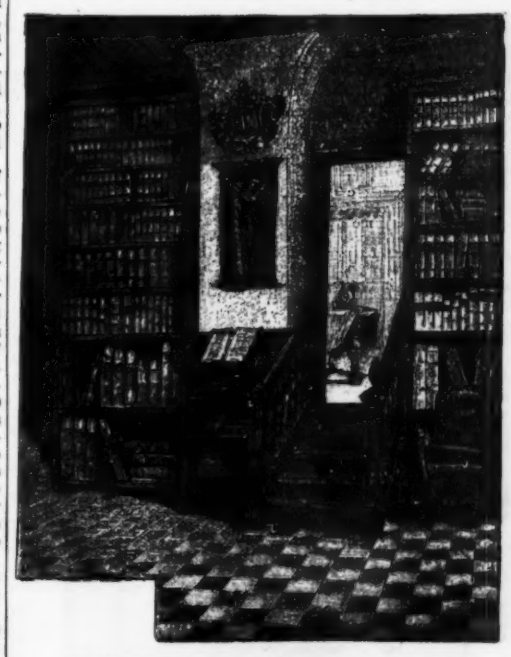


PLANTIN MUSEUM—THE COURTYARD.

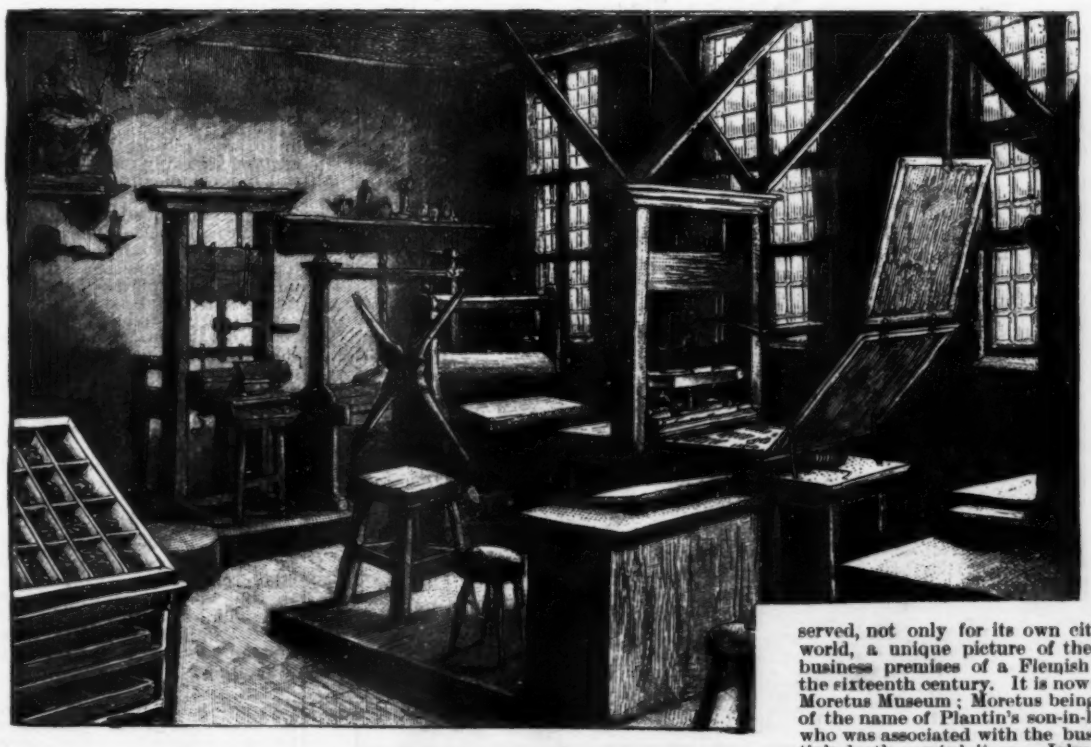
Christopher Plantin was born at Tours in the year 1514, and went, when a lad, to Paris to study. His father, owing either to negligence or poverty, left the young man to his own resources, and he consequently bound himself apprentice to a printer at Caen. After his marriage he went to Paris and perfected himself in the art of binding and leather working. At the age of thirty-five he established himself as a bookbinder and leather coffer maker at Antwerp, at that time the most flourishing city in the northwest of the Continent. He soon made a reputation as a clever worker in leather, and his embossed and gilt work surpassed in beauty all that had previously been done in the Netherlands. While taking home a coffer made for the secretary of Philip II. of Spain, he was attacked in mistake by some masked revelers, and so wounded that he was rendered thenceforth incapable of working at his trade as a binder, and so took up again the profession of a printer, which he had practiced at Caen. Some five years previous to this, when enrolling himself as a citizen of Antwerp, Plantin had joined the guild of printers; which shows that, although he practiced leather working, he always regarded as his real business that art which was destined in succeeding years to bring him so much fame. The first book which he printed is dated 1555, and is entitled "La Institutione di una fanciulla nata nobilmente," and, besides the Italian text, it contains a translation into French. In the preface Plantin formally announces it as his first book. For the next seven years comparatively few books were published by him, and the progress of this epoch, though real, was modest. In 1562 he was accused of printing an heterodox pamphlet; and, though nothing unorthodox could be found in his conduct, three of his workmen were sent to the galleys, and he himself deemed it prudent to retire to Paris for a year. A little later, however, he resumed his business by entering into partnership with some friends, and was thus enabled to greatly extend his trade.

Although Plantin seems to have been a man of pretty liberal ideas, and notwithstanding his undoubted association with Jansen and other men of the time not noted for their orthodoxy, he supported the Catholic church and that infamous wretch the King of Spain. Indeed, from 1567 he found his chief support in Philip II. and his ministers, Cardinal Granvelle and Gabriel de Cayas. By the favor of the latter he obtained the privilege of publishing the "Royal Bible," which was printed in five languages. This book, known as the Polyglot Bible, was Plantin's chief work; and, indeed, we may say it was the most important work that was ever printed in the Low Countries. The King of Spain advanced the sum of 21,200 florins toward the enormous expense of printing this Bible, and sent one of his chaplains, learned in languages, to supervise the translations and correct the proofs of the sacred text. The production of this work occupied about five years, during which time Plantin also printed his first breviary and missal, after the versions authorized by the Council of Trent. The Pope's printer having the sole right to publish these books, Plantin made an agreement with him by which, on giving the Italian publisher one out of every ten copies, he was allowed the privilege of selling these books in the Netherlands. In 1570, however, Philip II. granted Plantin a monopoly for the printing of mass books and prayer books for the whole of the Spanish dominions. This privilege not only freed Plantin from his obligation to the Italian publisher, but laid the foundation of the future prosperity of his printing house. From 1572 missals, breviaries, psalters, antiphonaries, the offices of the Virgin, and other prayer books, in all editions, were issued in thousands by the Antwerp establishment.

But, notwithstanding these royal favors and privileges, the already famous printing house was destined to suffer many reverses. The revolt of the Netherlands brought trade to a standstill, money was scarce, Plantin's books stayed on his shelves, and he was forced to sell at a loss quantities of books, materials, and goods, to pay the extortionate levies of the Spanish government. Indeed, he got into debt, and was forced again to desert the house which had been the scene of so many labors and triumphs. In 1584 Plantin fled to Leyden, remaining there until the following year. Upon Antwerp being taken by the Duke of Parma, he once more returned thither. When Philip II. charged Plantin with his enormous undertakings he had promised him ample subsidies, and on the completion of the Polyglot Bible had conferred on him a pension of 400 florins. Unfortunately for him, the king's exchequer was in a still worse condition than his subject's, and he never received his annuity, nor did he ever get a penny of the enormous sum due to him by the king at the time of his death. After the sack of Antwerp, in 1576, Plantin had to retrench his expenditure, and, accordingly, he occupied only half of the building which is the subject of our illustrations. But in 1579 he bought the other half, and from that day until quite recent times this most interesting house has been occupied as a printing establishment by Plantin and his descendants and successors.



PLANTIN MUSEUM—THE LIBRARY.



THE PLANTIN MUSEUM—THE PRINTING ROOM.

The monopoly of printing prayer and church service books was withdrawn from the firm in the year 1800, when the premises were temporarily closed as a printing office, and afterward it was used for that purpose only at intervals down to 1875. In that year the city of Antwerp, with most commendable public spirit, bought the building, with its antique furniture and splendid family portraits, its printing materials, machinery, and appliances, and all the stock in trade contained on the premises. By this praiseworthy and timely act Antwerp has preserved, not only for its own citizens, but for all the world, a unique picture of the dwelling house and business premises of a Flemish trader of the end of the sixteenth century. It is now known as the Plantin Moretus Museum; Moretus being the Latinized form of the name of Plantin's son-in-law, John Moerentorf, who was associated with the business, and after Plantin's death carried it on. John Moretus followed in the traces, and respected the traditions of his father-

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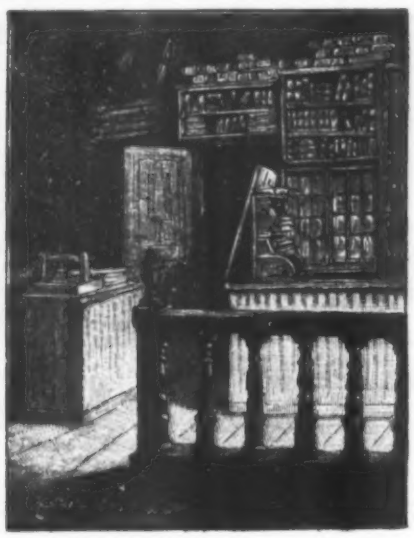
THE PLANTIN MUSEUM—THE TYPE FOUNDRY.

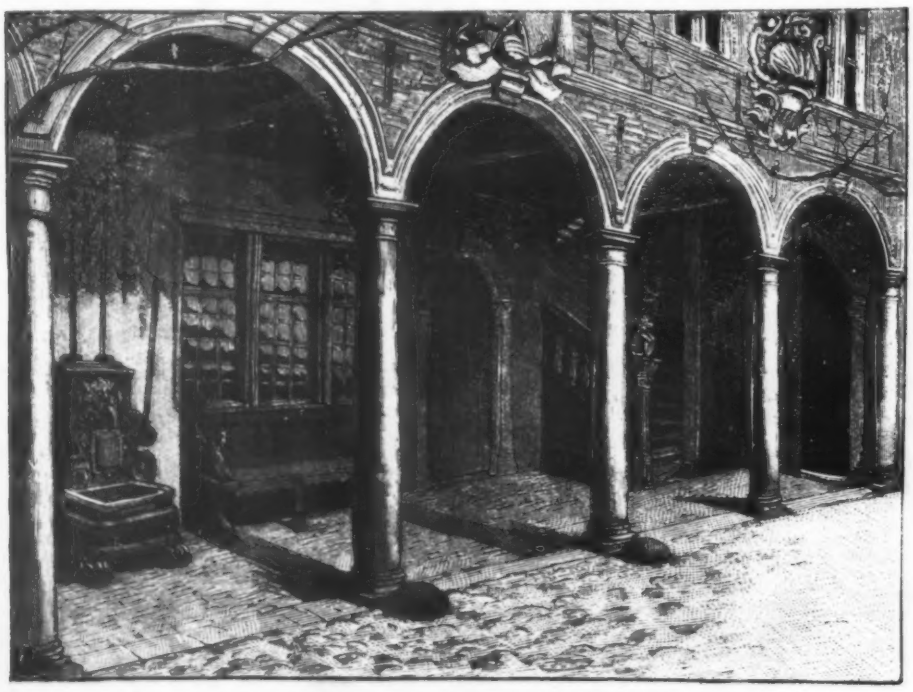
in-law; and, fortunately for us, his successors continued the same policy and made but few alterations either in the appliances or the building. Thus to-day we have the implements, the materials, and the produce of this famous mediæval printing establishment and the furniture of a prosperous burgher's house pre-



THE SALE ROOM.

served to us, and arranged pretty much in the very way that they were when the Moretuses lived in the house and directed its affairs. This famous and attractive museum is situated in the southwest corner of the small Marche du Vendredi, near the beautiful cathedral and the massive town hall, and close to the quays of the River Scheldt. The facade was constructed during the last century, but it did not interfere with the rest of the older buildings, which run round a central courtyard—a characteristic feature of the building. The architecture, which is largely domestic Gothic, with an admixture of Renaissance, is

THE PLANTIN MUSEUM—THE PROOFREADERS' ROOM.



THE PLANTIN MUSEUM—THE CLOISTERS.

eminently attractive, and the effect, though homely, is artistic and pleasing.

Most of the building is two stories high, with dormer windows in the roof, and an arcade running round three sides of the courtyard. Over the gallery, on the north side, are several busts of the more famous directors of and successors to Plantin's business. Among them is one of Balthasar Moretus II., which dates from 1688. In the corner, underneath these monuments, is seen the staircase built in 1621, with carved rails and pillar surmounted by a lion holding a shield with the arms of Balthasar III., who was ennobled—that is to say, made a "gentleman of coat-armor"—in 1692 by the King of Spain, and obtained the privilege of carrying on his craft without compromising his nobility. Further on are seen an old carved bench and a curious seventeenth century pump of blue marble, with a sculptured bronze spout. On the right of the vestibule is the entrance to the reception rooms, all handsomely and comfortably furnished. The walls are hung with fine old Flemish tapestry, and on them hang many admirable family portraits. Several of them are by Rubens, who not only painted the portraits of members of the household, but designed title pages, frontispieces, and other illustrations for the works printed by Plantin. Indeed, so close was his connection with the family and business that local rumor assigns to him the position of son-in-law to Plantin, though strict historical record does not bear out such a tradition. The original receipts signed by Rubens are still preserved, and show the actual sums paid to that great artist for designs used by the printers. Many of Rubens' vignettes, drawings, and title pages are also carefully preserved under glass cases.

At the end of the mediæval-looking court, one side of which is entirely covered by the branches of an aged vine, are situated the sale rooms, with separate entrance from the side street; they are embellished with old tapestry and oaken paneling. On the other side of the court is the printing office, where everything is now arranged as if work were to be resumed to-morrow. First comes the proofreaders' room, with its little compartments and tables and benches of carved oak. On the desks lie old proof-sheets, first impressions, and other documents, vividly recalling the work of the past. Next to this are the proprietor's office, with gilt leather hangings reminiscent of the craft once so ably practiced by the master, and the so-called room of Justus Lipsius, with Spanish leather hangings, where the great critic and philologist is said to have been lodged while visiting his publisher Moretus. A passage leads hence to the type foundry, with furnaces, matrices, and other old-fashioned appliances for casting type and making the blocks and requirements of the printers' business. Next it is the composing and printing room, which contains, besides the cases of type, two hand presses of the sixteenth century. On the first floor are situate many fine reception rooms, now used as receptacles for books, pictures, engravings, and curios belonging to the family and connected with the business. Further on are the bed rooms, furnished and swept and garnished as if the late occupants were going to return at night. From one of the living rooms a few steps lead into the library, which is a comfortable room, fitted up just as it was in old Plantin's time, and having little resemblance to the more museum-like rooms above, where copies of all works printed by the firm are stored and classified. Other rooms contain hundreds of copper plates after Rubens, Jordaens, Van Dyck, and other artists, together with proofs thereof and numerous fine specimens of early printing. To those who know anything of the typographic art, an examination of these relics of an old printer's business is most fascinating; while to the ordinary tourist the house forms undoubtedly one of the most attractive museums in the world.

THERE is one place in the world, at any rate, where the streets are literally paved with gold. At Johannesberg it has been found that stone recently supplied by a mine on the main reef for paving the streets yields six dwts. to the ton over the plates.

LIBRARY 15273

A SIMPLE INHALING APPARATUS.

IN most of the affections of the bronchial tubes or larynx, physicians recommend inhalations of aromatic substances—turpentine, eucalyptus, pine sap, etc. If the treatment is to be but transitory, the patient will perhaps find some advantage in constructing the apparatus designed for such purpose for himself, and will not judge it *apropos* to purchase an instrument that will soon remain without any use.

In many cases the inhalation may be practiced with a simple tea kettle placed upon a chafing dish, and the spout of which is provided with a funnel fixed through the intermedium of a cork or a piece of rubber tubing. But hot steam is often disagreeable, and it is always dangerous to place a chafing dish upon the bed of an invalid.

These two inconveniences may be suppressed by a

A SIMPLE INHALING APPARATUS.

very simple arrangement. Close the tea kettle with a wooden or cork stopper in which an aperture has been made for the reception of a bent tube entering the liquid. Connect this tube by means of a rubber one with the nozzle of a bellows. A current of air on being sent into the tea kettle by the bellows will cause an energetic bubbling, and, in its passage, will become charged with aromatized steam, which escapes at a temperature at which it is in nowise disagreeable to inhale.

The advantage of this process is that it is not necessary to cause the water to boil in order to obtain air highly charged with vapor. The inhalation may be begun after the tea kettle has been taken from the fire, and be prolonged until the temperature of the water has reached about 50°.

The tea kettle may be placed upon a bed without any danger, and, if the patient is in a state to work the bellows himself, he can moderate or quicken the flow of vapor at will.

We show the method of using the apparatus in the accompanying engraving. The arrangement that we point out is that which requires the fewest resources foreign to a household; but one might, with advantage, substitute a tubulated retort for the tea kettle and a rubber bulb for the bellows.—*La Nature.*

WATER GAS IN SMALL WORKS.

THE great growth of water gas throughout the country and the fact that nearly all of the large and medium sized gas companies have adopted it, has made many of the smaller companies debate the question of whether they too might not install it to advantage. In the consideration of this matter, the question very naturally arises as to how much of a change in existing works may be necessary; whether water gas can be easily put in a coal gas works, and, in brief, in what manner it should be arranged. In answer to such questions, and especially as of interest to the smaller companies, we illustrate and describe herewith the arrangement of a typical water gas plant as added to a conventional coal gas works, and that the instance may preferably be one of reality rather than a suppositious case, an actual current example has been selected for description.

The cut is sketched from the works of the Hanover Gas Company, of Hanover, Pa. The water gas plant now in course of construction for it is one of the standard sets for small works of the United Gas Improvement Company's well-known Lowe form, and in view of the many years' experience in design and construction work and the standing of this company, it may be assumed that the arrangement is a correct one.

The old plant may be described as a regular 6 in. coal gas works. To the left, in the cut, is the usual retort house, containing 3 benches of 3's. Beyond it is the purifier house. This side of it (and adjoining) is a coal room extending up to the railroad switch. In addition to the benches, the old machinery comprised a small boiler, a coke scrubber, a vertical pipe air condenser, 4 small boxes, a small meter, and a 16,000 ft. storage holder. So much for the old outfit.

In considering a water gas machine, the first question was, where to put it and avoid the expense of a new building. Two courses were open. One was to locate it in the retort house in the space gained by removing the oldest bench, using the old foundations. As the roof was at the usual height of 16 ft. or 18 ft., this was quite feasible, giving plenty of room. A still better plan, however, was determined upon, which was to locate it the other side of the wall in the coal house, as shown in cut. In this way it was kept out of the dirt of the retort room; the benches were left entirely undisturbed, and the space taken in the coal house caused no loss, for the reason that with water gas not more than half as much coal storage is needed as compared with coal gas.

The old coal gas scrubber was both unsuitable in design and too small to handle the gas from the rapid making new machine; so a new capacious water gas scrubber was supplied and located in the corner, conveniently near the machine proper. Immediately alongside it also was located the new steam boiler (not shown), and in the adjoining room, out of the dust, etc., the engine and blower; so that, in brief, all parts of the new outfit were immediately near the gas maker, enabling one man to easily run everything. From the groups of water gas parts; the gas take-off pipe led directly to the old take-off pipe from the hydraulic main, at which point the two systems connected. This being so, it is at once evident that the arrangement simply made a double-stringed gas works, having two ways of producing gas. Either coal or water gas, or both, could be made at pleasure, the two systems then joining together, and the gas passing on through the works in the old way through the old pipes. Or, even more briefly, it could be covered by saying that the water gas plant was simply added to the coal gas system.

One might naturally suppose that there would then be nothing more to do than to start up and make gas. A very important point, however, was yet to be considered, *i. e.*, that of pressure on the boxes, etc., due to making water gas so rapidly. While water gas, generally speaking, requires no more purification than coal gas, and is purified in precisely the same manner, yet it is evident that while a small set of boxes, as at Hanover, might handle a given make, say 25,000 ft. or 35,000 ft., made in twenty-four hours, if that amount were made and crowded through them in a few hours high pressure would result and trouble might ensue from blowing the seals, or the formation of blow holes in the lime or oxide, allowing gas to pass through unpurified. Further, the same high pressure upon a station meter alters the water levels, and makes incorrect registration. To minimize all such possible troubles, a small second or relief holder was decided upon and put in. This was simply a diminutive but regular gas holder of 3,000 ft. to 5,000 ft. capacity in a wrought iron tank, entirely above ground, involving but a slight expense for foundation, and avoiding all uncertainty of cost of the usual excavated brick tank in the ground.

This holder is so connected that if at any time during a run the water gas machine makes more gas than ought to pass through the boxes, the excess gas will pass into it, and there be temporarily stored until the run is through with. Then, during the time of blowing up, or getting ready for the next run (when no gas is being made), this excess gas in the small holder is passed on through the boxes. In this way the gas passes through them at only half the rate that it is really made by the machine, and the initial intermittent make and high pressure of the water gas does not get beyond the small holder, but is absorbed by it, so to speak. From that point on the gas passes along at a uniform rate and moderate speed through the boxes and meter, and at a low pressure; not exceeding whatever pressure may be given by the relief holder.

To pass the gas, as above, from the relief holder, through the boxes and on into the large holder, several means may be employed. In a small works, such as Hanover, the simplest is to have the small holder heavy enough to force the gas through. Where, however, the general connections are small, or there is much back pressure, this may not be sufficient, and in that case an exhauster is usually used, so connected that it draws the gas from the relief holder and passes it on precisely as though it were drawing from the benches. As most companies already use an exhauster, this means no added expense, and is the arrangement usually employed.

The above method of operating with a relief holder is the most satisfactory method of making water gas, and is always recommended to be adopted where possible by the United Gas Improvement Company, whose apparatus we are considering. It is the preferable method, but that it is not absolutely necessary is shown by the numerous companies making water gas directly through the boxes with only one holder. In such case the purifier seals are deepened, if possible, or arranged with clay, or the paraffine wax device of Mr. Shelton, of the above company, in place of water, to prevent blowing off the seal under the intermittent make and high pressure of direct connection.

Aside, however, from the question of smoothest operation, in conjunction with a water gas machine, the use of a small holder, as above, affords protection to the works in case of accident or repairs to the main or old holder. At Hanover, for instance, the connections will be so made that in case of emergency, purified water gas can be supplied to the town direct from the small holder. With coal gas, it would ordinarily be quite impossible, with only a 3,000 ft. holder, to maintain the supply during the hours of heavy consumption, but with a fast-producing water gas machine it is quite possible, though, of course, not economical. That this is so, is shown by an instance, known to us, where for years a water gas company has been working with a single 5,000 ft. holder only, though in winter the output reaches 35,000 ft. and even 50,000 ft. a night. This, at least, shows what can be done.

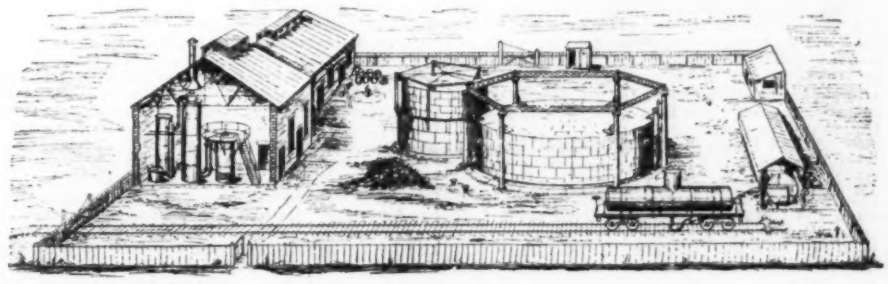
For the storage by small companies of the oil necessary for the manufacture of water gas, various arrangements are followed. An iron oil tank of either horizontal cylindrical form, or vertical cheese box style, may be located out in the air on the sills, or on a pier, or under roof in the coal shed, or in an excavation or pit in one corner of the lot, according to local conditions and individual ideas. The last arrangement mentioned is that at Hanover, as shown in cut, and is undoubtedly one of the best, for while accidents in reality rarely happen to storage oil tanks, and then usually only through the grossest carelessness, yet they are possible, and in case of such contingency—and to satisfy the insurance men—it is better to have the tank somewhat apart from buildings, and in an excavation or pit. Then, in case of accident, the pit, by holding the oil in it, prevents its flowing toward the buildings. Setting the tank in a pit, moreover, gives a fall, often enabling the unloading of tank cars entirely by gravity, so avoiding the use of a pump.

In cases where no railroad switch, as above, exists on the gas premises, a pipe line that may be a half or even a mile in length is run to the nearest siding or point of unloading; or a tank wagon may be used where a pipe line would be of too great length; and it may be added that the cost of procuring oil, even by team hauling, need not exceed a fraction of a cent a gallon. The general arrangement of works and plant outlined above is that followed at Hanover, and is shown in the cut, and behind and to the left of the main gas holder may be seen the new 3,000 ft. holder in steel tank above ground. Excepting for this and the oil house, scarcely an external evidence can be found that the works have been changed from the coal to the water gas system.

As such an essential portion of the typical water gas works described, brief mention of the typical water gas machine itself there installed is not amiss. In form it is the standard of the United Gas Improvement Company for small works, known as the single superheater setting; in distinction from that company's well-known double superheater setting, so generally used in the larger works. That is, while the standard double superheater form is found best for satisfactory working, for the handling of various oils in a manner that no single superheater form will do, and for the fullest duty that may be thrown upon it in a sizable works, yet in the smaller works, where the work is lighter, and the operation limited to a very few hours, the single superheater form is found to be sufficient. This enables also a low first cost—an important point to small companies. The generator is deep, allowing the use of gas house or oven coke, as well as of anthracite; a heavy fire brick lined flue connects it with the superheater. This vessel, so essential for a good quality of gas, has large fixing capacity; is liberally supplied with manholes, and while 18 ft. in height, yet easily went under the gas house roof by letting the top interpose between the tie rods.

The oil heater is located in the take-off pipe to the seal, the heat of the hot gas being used to vaporize the oil. In this way a much higher temperature and fuller vaporization is obtained than can be had by a steam jacket or coil heater. From the hydraulic seal or washer, the gas passes to the special water gas scrubber already mentioned, and thence on through the existing old coal gas pipes, relief holder, boxes and meter, to the main holder, etc., as described. Throughout the apparatus the careful design and quality of work of the United Gas Improvement Company is evident, and a feature of the apparatus noted is the unusually full outfit included; those items that often appear as extras, such as auxiliary machinery, iron floor and stairs, coal hoist and bucket, and even clock and fire tools, etc., apparently being part of the regular complement.

It may be observed that the above form of typical small water gas apparatus is purposely not equipped with reverse steam connections. While such have for



WORKS OF THE HANOVER GAS COMPANY, HANOVER, PA.

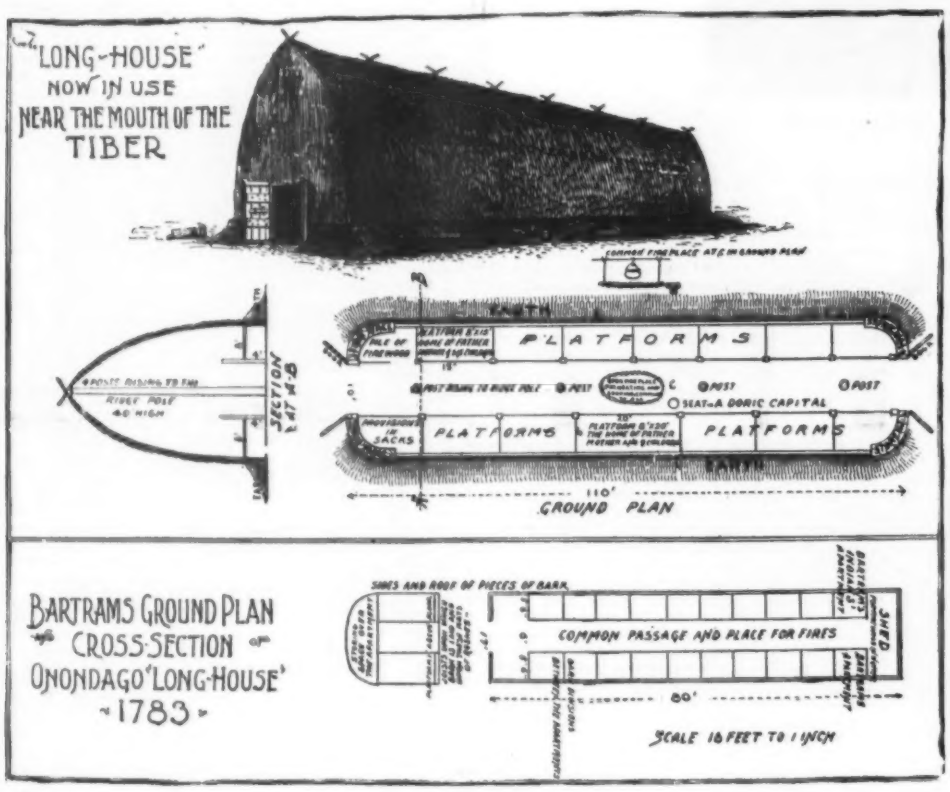
long been part of this company's form for larger sets, it is claimed by it that for small works simplicity should be preserved above all things; and while hot valves and reversed courses of the gas, etc., may, under other or especial conditions, be desirable, they certainly are not for an apparatus of the size here considered, not only showing no advantage in operation, but positively disadvantageous, in addition to the extra first cost.

Take it as a whole, the plant at Hanover is a typical one for small companies, and we doubt not but that the local company will speedily attain, as have other companies, the numerous benefits attending the modernizing of its works.—*Light, Heat and Power.*

SOME ITALIAN "SURVIVALS"—A "LONG HOUSE" IN THE TIBER DELTA.

By ROBERT H. LAMBORN, Ph.D.

AROUND the Eternal City, within easy riding distance, one may study many surprising phases of civilization. Six miles northeastward across the Campagna from the Porto del Populo, in a secluded valley far from the beaten roads, on the lands of Prince Borghese, I found several families numbering twenty-six persons, living in caves with their shaggy white dogs. They subsisted by gathering wild chiccory for Roman salad eaters, and by begging for alms at the city gates. A furlong from this cave is a veritable cliff dwelling. A deep cavity in an almost perpendicular escarpment of tufa rock is reached by a zigzag path. Its entrance is closed by a swinging bundle of bush, and within, the irregular floor is divided by rough stone walls into pens resembling those in a Colorado cliff dweller's habitation. On the western slope of the Alban Hills I once dismounted to inspect a flour mill owned by the Cenci family, where the vertical shaft of a horizontal flutter-wheel carries the diminutive grinding stone and the water flowing from a historic Etruscan drainage tunnel shoots down a steep stone channel, and dashing out a sparkling shower, whirls the toy-like wheel with all the prettiness and childish carelessness of force expenditure that one may see in a New Mexican Indian corn mill. The shepherds on the broad domain of Prince Torlonia live in beehive-shaped *capanne*, built of brush and reeds almost as simple in construction as the dwelling reared by our Western beaver. Their rent they pay weekly by selling ewes' cheese, made over a fire kindled on the earthern floor close to the bunk in which the shepherds sleep.



On April 13, 1888, I rode by the Via Ostia, through the Tiber Valley, to the district where that river divides and enters the Mediterranean. I reached, not far from the sea, the property of Prince Aldobrandini and soon approached his country seat, near which arise four curious and conspicuous structures, in close proximity to the roadway. At first they seemed to be huge hay-stacks, the stored herbage of Tiber's fertile delta, but nearer inspection proved them to be houses. It was quickly evident, too, that they did not lack inhabitants, for a number of women and children flocked from an opening in the eastern end of the largest structure, and stood awaiting my approach. I was so strongly reminded of the "Long House" of the Onondaga Indians as given by Morgan (after Bartram) in his "House Life of the American Aborigines," that I handed my reins to a young man who had approached expectantly and entered the open doorway; men and women coming forward with alacrity to show me the interior economy.

I was told that this, with the three additional structures, were the dwellings of the laborers on the Aldobrandini estate, and that about 70 of the total population of about 250 found in this house their home. Its form is best shown by the accompanying sketches made in my note book on the spot. It is 110 feet long, about 26 feet wide, and is drawn to a comb about 40 feet above the ground. Vertical and horizontal poles form the framework, upon which are fastened osier walls, overlaid by flags and reeds gathered from the neighboring lagoons, thus producing a wind and rain proof covering. The storms and sunshine of years falling upon this thatch of water plants gradually change their color until the exterior is as black as a stack of clover hay. Only two openings, one at each end, admit you to this windowless house, and these are closed at night by heavy plank doors that are swung together and securely barred.

In the corner to the left was a pile of dry fagots, the common property of the community. This fuel is burned upon a hearth that occupies a central point upon the earthen floor. Over a smouldering fire on this hearth a brass kettle was simmering, and a wreath of smoke ascended into the gloomy, chimneyless upper spaces. On both sides of the middle passageway, and raised about four feet above it, was a long platform of rough plank. These platforms were divided by board partitions, about three feet high, into pens varying in length according to the number of persons intended to be accommodated, but averaging for each individual a floor space of about two feet by eight. Thus to one family of eleven persons was apportioned a pen twenty feet long by eight wide, which answered for them every purpose of a home; another, fifteen feet by eight, was occupied by a father, mother, and six children. These divisions held the boxes, clothing and sleeping arrangements of the family. In them children were playing mothers nursing, and several sick persons were lying wrapped in dark woolen blankets.

I see no reason to believe that this structure, and the method of living practiced therein, varies essentially from that which existed in the Maremma when Pliny possessed a villa near this spot, and when Cæsar drew his soldiers from among the forebears of these Roman peasants. We all know how slowly the habits of the lower classes change in old countries, and even residences in the most enlightened Italian districts show but little development since imperial times. Goethe relates that after visiting Pompeii with Tischbein, 1787, he entered a neighboring occupied dwelling which with its furniture seemed to him to resemble perfectly the habitations he had just studied in the mummied city, built more than twenty centuries ago. Indeed it is possible that this curious Aldobrandini dwelling is a survival closely imitating the form of house constructed by tribes that dwelt in this valley long before Rome was founded—when the Capitoline hill was a sheepfold in the prehistoric period of the Ausonian peninsula. This possibility is strengthened by the fact that all the materials for the house are of local production, are easy to transport and require only the simplest tools to assemble and erect, while the result is an enduring and excellent shelter. An additional and striking evidence of the aboriginal character of the structure is the close parallelism shown in the American "Long House" already mentioned, which was habitually built and inhabited by some of our best known savage tribes. For purposes of comparison I have reproduced here Bartram's sketch of the Onondaga "Long House," made on the occasion of his visit to attend a council of that tribe in 1743. It was 80 feet long and 17 feet wide. A common passage, in which the fires were built, ran between two sets of occupied apartments. These apartments were raised about a foot above the level of the passage on two platforms made of hewn saplings, that extended along both sides of the house.

They were formed by erecting bark partitions upon the platforms, and one division was allotted to each family. Soft pieces of dry bark and sleeping mats were spread upon the rough floor, and a fire for each four apartments kept the house warm and served for cooking. Above each fire a vent in the roof allowed the smoke to escape. Extending over the apartments was a sort of second story in which household effects could be deposited A corner in this dwelling was devoted to the common store of firewood.

"Long Houses," resembling the one pictured by Bartram, are transcribed by Greenbalge, who visited the village of the Iroquois-Senecas, near the present site of Rochester, in New York, in 1677. One was about 100 feet in length, made of a strong framework of poles set in the ground and covered with strips of elm bark tied to this frame with strings. The living apartments were arranged as described in the Onondaga house. Skins, forming curtains, hung over the entrances, and from the roof were suspended bunches of Indian corn ears with their husks braided, and festoons of bits of dried squashes and pumpkins strung upon long pieces of cord.

My visit to this cheerful community in the Tiber delta, I regret to say, was too brief to allow me to enter upon the study of its domestic economy. Valuable material for comparison with the Indian customs would be obtained by investigating how far the property and supplies, such as firewood and food, are procured and held in common, and what household habits had developed to increase the convenience and comfort of families crowded into a place so restricted. But my destination that day was further southward along the blue Mediterranean, to the beautiful Castle Fusiano, with its vast domain of towering pine trees, where for miles one may gallop over smooth roads made fragrant by myrtle and sweet daphne, with long level reaches where the shadows are as profound as those that darken the primeval forests of the Alleghanies.—*Science.*

EDISON'S PHONOGRAPHIC LEVEE.

MR. EDISON held a levee recently in his laboratory at Orange, N. J. For the first time, he listened to the voices of European emperors, kings, statesmen, poets, artists, and of other potentates and potentialities who for years past have been addressing him through the medium of his European colleague, Col. George Edward Gouraud. These messages of congratulation, admiration, and declamation, intermingled with scraps of verse, snatches of song, and ripples of laughter, were at various times and in various places talked into phonographs belonging to Col. Gouraud, and then the cylinders were sealed and packed away till such a time as the colonel could visit "the Wizard" in his American home and personally hand the precious souvenirs to him. Of this opportunity Col. Gouraud has now availed himself. Transcripts of the messages had of course been sent to Mr. Edison by mail, but the actual voices he only heard recently, and of these voices not a few have now passed away to the Silent Land.

It was only a family party in the library of the laboratory. Mrs. Edison was present and so were two sons of Edison's first marriage—thoughtful-looking, well-dressed lads of 18 and 16—and Mrs. Marvin and Miss Miller, sisters of Mrs. Edison. Then there was a niece, a tall, pretty blonde, Miss Edith Edison, and a brother-in-law, "Freshman" Miller from Yale. Col. Gouraud was accompanied by his son, Fauvel Gouraud, by Mr. A. Graham, an English electrical inventor of some note, and by Mr. John Beaufoy Lane, a London journalist.

The unique treasure box of science was carefully unsealed in the presence of Mr. Edison, and then the row upon row of cylinders were revealed, duly labeled with the names of the owners of the voices that were concealed in their waxy circumferences.

The first voice placed on the phonograph was singularly appropriate to this Eastertide, and yet a solemn and touching beginning to an occasion which could not fail to evoke much varied feeling in the hearts of all of the little party present. It was the voice of the late Cardinal Manning, Archbishop of Westminster. Clearly yet softly came the words of the dead prince of the Roman Church:

"A hearty greeting to the inventor of the most wonderful instrument of modern science. Henry Edward, Cardinal-Archbishop. Easter Day, 1891."

After the cardinal came a few royalties, beginning with his majesty of Greece. This monarch over the realms of the classics has a powerful voice, and he spoke in Greek. It must have been rather indifferent Greek, as nobody understood him, but his signature, "Georgius," was very loud and impressive. In a general way he was understood to express his regret that the phonograph was not in vogue in the days of Homer. The present King, Queen, and Crown Prince of Italy followed. Their majesties and his royal highness talked in excellent English, barring their natural Italian accent, and all three briefly expressed eulogiums of Edison and his inventions. "A return of fairy days," said Queen Margaret, and Prime Minister Crispi granted a few words of complimentary approval in French. King Umberto added that he hoped Edison would frequently wear the Italian order of knighthood he had sent him.

"It is in the glass case with the other medals," said Edison.

Next came words in a weird and most unknown tongue, yet musical in their intonation. They were revealed as the voice of one Burghast—or something of that sort—Effendi, a Persian poet in the suite of the Shah when that "King of Kings" last visited Europe. His "Immensity" declined to speak himself, and so did the princes in his suite; but the poet was commanded to be equal to the occasion. He probably was, but his declamation to Mr. Edison seemed to weary the Wizard, who observed at the conclusion of Mr. Burghast's effort, "I've got as much sentiment about me as a locomotive." He listened, however, with an amused smile to the next voice, that of Mrs. Bancroft, the actress. She also recited a poem. "What We Do at the Springs," a lively skit on life at a German spa. Every verse terminated with a burst of laughter from the actress—the inimitable laugh that has convulsed thousands of audiences. Edison and family soon caught the infection; but it faded away while husband Bancroft recited something from "London Assurance."

Then came a group of military voices, beginning with the Duke of Cambridge and Gen. Lord Wolseley. They were mainly Christmas greetings and congratulations to Edison, spoken at a dinner specially given to Col. Gouraud to meet the royal commander-in-chief of the British army. Then came the Prince and Princess of Wales, spoken at Sandringham when Col. Gouraud was one of a house party which included the Empress Frederick and her daughters and the late Duke of Clarence. "I am delighted with this charming instrument," said the voice of the Princess of Wales. "Yes; most wonderful, most marvelous," rolled out the voice of the prince. Then came a word or two

from Lord Salisbury: "I can add nothing to that which their royal highnesses have just spoken."

THE GRAND OLD MAN SPEAKS.

England's greatest and grandest old man came next, and the face of Edison lit up with pleasure. The cylinder began by stating that Mr. Gladstone was present at one of the "Round table dinners" given by Mr. James Knowles, editor of the *Nineteenth Century*, at Queen Anne's Lodge, London. The company included Lords Aberdean, Meath, Playfair, and Rowton (Disraeli's secretary), Sir Morell McKenzie, and Sir John Fowler, the great engineer. Gladstone's voice was clear and sonorous. There was an absence of the broad "a," but a presence of a broad roll to all the "rs."

"I cheerfully comply," said he, "with the request you have done me the honor to make, but I regret to say that I can only send you the remnant of an organ that has been overstrained. As much of my voice as is left I gladly give you. Wonders upon wonders are opening up before us. Your great country is leading the way in the great work of invention, and to you, as one of its greatest celebrities, I send my hearty good wishes for all that pertains to the well-being of mankind. To Edison. WILLIAM EWART GLADSTONE."

Two dead but never-to-be-forgotten minstrels followed, Tennyson and Browning. The dead laureate began by exclaiming that he never could remember a line of his own poems, so he begged permission to read something into the phonograph. The "something" was his "Ode to Wellington," dated from "Aldworth" and signed "Alfred Tennyson."

Browning failed in memory like his brother poet, but he began by trying to remember. His recitation was his poem, "How they carried the news from Ghent to Aix." The cylinder recorded faithfully the pauses of the poet—it all was so uncanny, if lifelike—"Oh, I can't remember, I can't remember." Then he d continue for a space, then "hum" and "haw," then he broke down and laughed merrily, and finally the cylinder recorded cheers and hand clapping. A crowd of artists were surrounding the poet, and the applause was led by Sir Frederick Leighton.

Mr. Edison, however, was still thinking of Gladstone. "He," he suddenly exclaimed, pointing to the record of Gladstone's voice, "he is the most marvelous organism that has been produced by nineteen centuries. The evolutions of another 500 years, however, may make such men common," and the Wizard looked at Col. Gouraud, but that gallant warrior was not equal to a reply. However, the colonel turned on Gen. Boulanger, the voice of the deceased French celebrity being preceded by a few bars of the march written in his honor. "I always like to hear that," said the general, in French, and then he followed with some exquisite, if verbose, compliments, and signed himself (verbally, of course) "Ernest Georges Boulanger, General en retraite."

The cylinder was completed by a few words from the Duchess d'Uzes, the wealthy and high-born French woman who is supposed to have found the money for the Boulanger boom.

Lord Armstrong, maker of great guns, spoke next. Before speaking, at the time the record was taken his lordship examined every part of the phonograph and went on his knees to look closely at certain portions. It was suggested that he would fatigue himself, and the man of mighty sounding metal was equal to the moment. He at once spoke into the phonograph: "This is an instrument of science before which any man may well kneel." Edison smiled as it rolled out to him.

Then came Lord Kelvin (Sir William Thomson), President of the Royal Society, whom Edison regards as the head and front of scientific attainment of this century. In his Scotch dialect, his articulation bristling full of the Scotch burr, were the words, "Of all the marvels I have seen and heard, the thing that astonishes me the most is the hardihood Edison showed in attempting to do it."

Lord Rayleigh, Secretary of the Royal Society, and another of the great scientific lights, continued on the cylinder: "If Edison had known as much about the known laws of the science, he would have known that he couldn't do it"—which is a scientific epigram with a vengeance. It may be added, however, that Lord Rayleigh is the first living authority on the theory of sound, and the greatest ever living, excepting perhaps Helmholtz.

The voices of a number of minor lights in the worlds of everything concluded the seance, and before farewells were given it was agreed by Mr. Edison and Col. Gouraud that their libraries of voices should be amalgamated and left as a hereditary trust to the eldest representatives of the Edison-Gouraud families. Fauvel Gouraud, a yound intending lawyer, about to graduate at Yale, was told that he could draw up the necessary papers.—*N. Y. Sun.*

ELECTRIC ARC LAMP FOR LANTERNS.

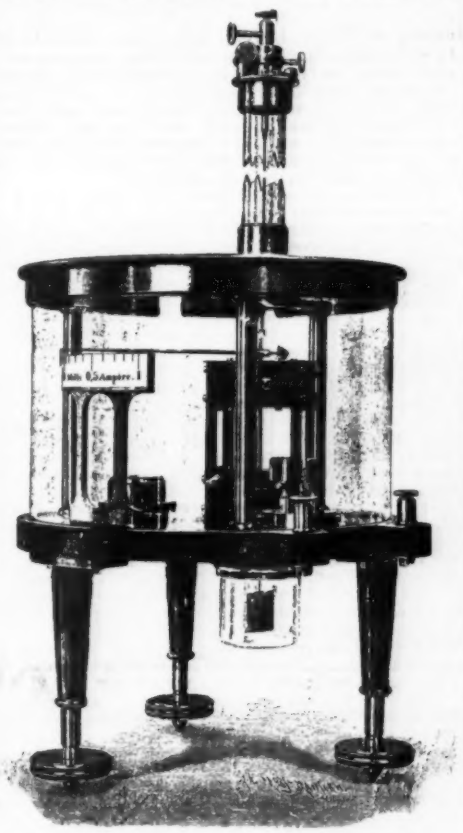
THE instrument is designed to overcome one of the obstacles to the use of electric light for magic lantern purposes, viz., that the users are often insufficiently acquainted with electrical processes to work the mechanism of an automatically-fed lamp to advantage.

ELECTRIC ARC LAMP FOR LANTERNS.

Davenport's lamp is a hand-fed one, consisting of two carbon holders, the lower of which is automatically kept in position by a spring, while the upper one is moved forward periodically by the operator's hand working a rod at the back of the lamp attached to a rack-and-pinion arrangement. This rod requires readjusting at intervals of about five minutes. The lower tube can be readjusted at will. The lamp shown in our illustration sells at £4 4s., but it may be had with a special connection, which renders it impossible to connect up in the wrong manner, at 11s. extra. The lamp will fit any ordinary lantern, so that, in case of want of electric light power, the ordinary limelight may be used. It has been used at the Society of Arts and the Camera Club with much satisfaction, and with the extension of stations for the supply of electricity there can be no doubt that it has a considerable future. J. H. Steward, London, is the maker.

A NEW ELECTRO-DYNAMOMETER.

SOME time ago an electro-dynamometer was constructed by J. W. Giltay on the well known principle of Bellatti. The instrument was very favorably received, but it was recognized that its usefulness might be greatly extended if it were capable of being standardized. Terrestrial magnetism exercised a very disturbing influence on this instrument, so that the reversion of a battery current flowing through it was attended with undesirable results. The difficulty has now been got rid of, and in a recent number of the *Annalen der Physik und Chemie* a new form of apparatus is carefully described.



A NEW ELECTRO-DYNAMOMETER.

The essential part of the instrument consists in two bundles of iron wire, in every respect similar to one another, which are suspended parallel to and above one another in similar coil frames. The turns of wire in the coils are similar in arrangement and equal in number. When a current is sent into the apparatus it circulates through both coils in opposite directions and magnetizes the iron bundles in such a way that they form an astatic system. In this manner the disturbance due to terrestrial magnetism is eliminated, and it becomes possible to standardize the instrument accurately.

In his paper Giltay describes with great minuteness the precautions which he observed in standardizing, and he makes use of the term "astasia" very frequently to denote the condition of the superimposed, parallel core bundles. There are also a number of tabulated results obtained from typical experiments illustrating the use of the instrument.

We may here observe that this paper is characteristic of that diffuseness which is so common in accounts of German research. In whatever else English scientists may fall short, they certainly do not, fortunately, err in this direction.

In the figure is shown a general view of this improved electro-dynamometer in a form which is specially designed for electro-therapeutic purposes. The index has a length of 11 cm.; it is marked by means of an aluminum needle. Each iron bundle consists of 116 wires of 0·3 mm. thickness and 18 cm. length. These are suspended by means of raw silk fibers situated 1·2 mm. apart. The index is parallel to them and makes, with the plane of the coils, an angle of 47°. Beneath the floor of the apparatus is a level and an ordinary plug commutator. When the two plugs are inserted in the proper holes the instrument is astatic, and is suitable for use with battery currents. When, on the other hand, the two plugs are placed in the other holes the instrument is ready for use with induction currents. Devices are inserted which make it impossible to injure the instrument by making wrong connections.

The theory of this electro-dynamometer is, of course, the same as that of Weber's electro-dynamometer.

The instrument illustrated was constructed for Dr. J. L. Hoorveg, at Delft. An account of it by him appears in a work entitled "Die Medicinische Electrotechnik und iten Physikalischen Grundlagen" (Leipzig, Engelmann), pp. 70, 129 and 130, where the methods of applying it in therapeutics are indicated and discussed.—*The Electrical Review.*

ANOTHER EARLY TRANSFORMER WITH CLOSED MAGNETIC CIRCUIT.

By A. M. TANNER.

ANOTHER contribution to the early history of transformers, or inductoriums possessing closed magnetic circuits, is the British patent of Thomas Allan, dated June 24, 1852, No. 14,190. The specification of this patent states that "the first part of my invention consists of improvements in producing induced electric currents by means of electro-magnets, which currents are applicable to various useful purposes. For the purpose of thus producing induced electric currents I compose an electro-magnet, or combination of electro-magnets, of several straight pieces of soft iron, so as to form an electro-magnetic circle, and I prefer to

FIG. 1.

FIG. 2.

form such magnet or combination of four pieces, but it may be composed of three pieces, or of five or more such pieces. I cover these pieces with the primary coil of insulated wire and then place the secondary coil, also of insulated wire, around the primary coil, and the pieces being straight they may have the coils wound upon them in a lathe with great facility. The pieces, having had the coils put upon them, are then to be connected at their ends, so as to form, when electro-magnetized, a complete electro-magnetic circle.

"The wires of the primary coils are then to be connected together, so as to form one continuous primary coil, the two ends of which may be connected with a battery in the ordinary manner. The wires of the secondary coils around the pieces of the magnet or combination are also to be connected, so as to form one continuous secondary coil, the two ends of which are to be connected with the line wires of an electric telegraph apparatus, or with the wires of any other apparatus to which the same may be intended to be applied.

"In Figs. 1, 2 and 3 I have shown the mode of constructing an electro-magnet, or combination of electro-magnets, of this description with four straight pieces of soft iron.

"Fig. 1 shows a straight piece of iron with the primary coil wound upon it, the ends projecting a little beyond the coils.

"Fig. 2 shows the same straight piece of iron with the secondary coil also wound upon it, and the ends of each of the coils are left long and projecting so as to be ready to be connected with any other wires.

"Fig. 3 represents four straight pieces of iron with primary and secondary coils around them, as already described, and the pieces joined together at their ends by nuts, screws or other means, so as to form an electro-magnet. The primary coils around the pieces are also joined together so as to form one continuous primary coil, the ends, A and B, of which are shown projecting and ready to be connected with the poles of the galvanic battery, which may be intended to be

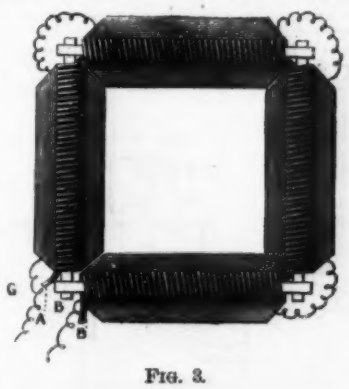


FIG. 3.

used. The secondary coils are also joined together in like manner, so as to form a continuous secondary coil, the ends, G and H, of which are shown projecting and ready to be connected with the wires of any apparatus to which the induced current of electricity may be intended to be applied."

The patent drawing relating to the transformer part of the invention is reproduced to illustrate the construction, which is very much like that of some modern transformers in which the primary and secondary coils are wound continuously in the same direction on the core sections. It will be seen that the description is silent as to the lamination of the core sections.—*The Electrical Review.*

TRACED BY FOLIAGE.—In tropical forests so large a proportion of the plants are of the sensitive variety that sometimes that path of a traveler may be traced by the wilted foliage.

[Continued from SUPPLEMENT, No. 955, page 15261.]

WATER TUBE BOILERS.*

IN this, the last of our series of articles on water tube boilers, we propose to consider the principles which should guide those who wish to design express boilers of minimum weight. The future demand for such steam generators will probably be large. Their use will, it is true, be almost wholly confined to ships or torpedo boats; but the growing demand for higher and higher speed, which can only be obtained by reducing the weight of the machinery employed to produce it, cannot fail to stimulate invention; and we do not, at this moment, know of any department of mechanical construction which holds out so many chances of reward to the inventor as the production of really excellent express boilers.

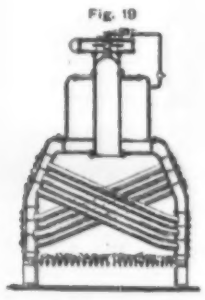
In a previous article we have pointed out that if a boiler is to be as light as it can be for the power, it must have no waste surface. We prefer the word "surface" to "material," because the former includes the latter, but the latter does not necessarily include the former. Surface represents weight. A boiler with very small surface might have very small weight, but its power would be small. The conditions of the problem, to the solution of which we desire to guide our readers, are that the greatest possible amount of surface shall be had with the minimum weight. By surface it is always to be understood that we mean useful surface; either surface employed in generating steam or holding it when made. It can be shown that in every boiler, or, more strictly speaking, in every plant, apparatus, or contrivance for the generation of steam, a certain proportion of the surface must be useless as far as the making of steam or the holding of it when made is concerned. To every boiler as to every bucket there is an inside and an outside. No more of the outside can be used for making steam than the area in contact with water inside. Heat may be applied with some advantage, however, to the surfaces in contact with steam to prevent adverse radiation, and keep the steam dry and hot. We find that in some boilers the whole outer surface is useless for steam making or heating. In others it is all utilized, and yet the waste surface is not minimized. For example, no portion of the outside of a locomotive boiler is heated. In fact, so far as steam making is concerned, the whole of the heavy shell, representing a weight of some tons, is of no account. In the case of Lancashire boilers the whole outside of the boiler isheated, steam space and all. But even then the whole surface of the apparatus is not used, because the insides of the flues, and of the brick setting generally, cannot make steam, and so far represent useless weight.

It is necessary to insist on this point, because, in not a few ostensibly express boilers, the weight of the useless surface is much too great to allow the boiler to succeed. At the same time there must always, and under all circumstances, be *some* useless surface, and the inventor or designer should endeavor to make this as small and as light as possible.

We have next to consider what our heating surface shall weigh. As a base line we may take its minimum weight as 5 pounds per square foot. That means soft steel, ⅛ inch thick, disposed in tubes 1 inch in diameter inside; such tubes may, if nearly vertical, have a length of 100 diameters—that is, each may be 8 feet 4 inches long. Greater lengths are not prohibited. The proportion we give it is perfectly safe to adopt. But a boiler cannot be made up of small tubes, unless indeed it is of the type described in our fourth paper, and has forced circulation; and it is on the way that the tubes are combined with other portions of the boiler that the final weight of the structure will depend. Provision must be made for the downflow of water, as well as for the uprise of steam, and of water driven up by the steam. There must be a steam collector, and a furnace or place wherein the grate is to be placed. Now there are three systems of combination, all in favor with different inventors. We have first the system very fairly represented by Fig. 19. Here we have flat-stayed surfaces composing a fire box. From the water spaces thus made originate inclined water tubes. Above all is placed a water heater for utilizing the waste gases. Secondly, we have the Thornycroft system, in which the sides of the furnace are made up of small water tubes springing from large tubes; and thirdly, we have the Yarrow system, in which the fundamental principle of construction is the same as the Thornycroft.

Now it can be shown in a moment that Fig. 19 cannot

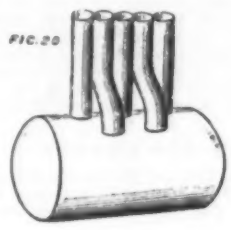
Fig. 19



give us the lightest possible boiler. It would not be safe to make the sides of the chambers less than ¼ in. thick and they must be stayed with ⅝ in. stays spaced 4 in. apart. A water space of at least 1 in. must be allowed between the plates, and opposite every tube end must be a screwed plug. The stays limit the number of tubes that can be used very seriously; but leaving this consideration on one side, we find that a square foot of heating surface in the sides cannot weigh less than 24 lb., the useless outer plate being, of course, included, and this allows nothing for the "making up" of the ends, top, and bottom of the flat chambers. It may be taken as proved that the lightest sides that can be used for a fire box are made of tubes. But if we use tubes only, what are we to do for an inclosure to keep the products of combustion in and cold air out? The boiler shown in Fig. 19 needs very little of this, because it is, so to speak, self-contained. In the Yarrow boiler the products of combustion pass outward directly to a space between the outer tubes and the side doors, or smoke box doors, as we may call them.

In the Thornycroft boiler the lower or furnace portion of the boiler is made self-contained by bringing the tubes of two rows into contact, which is done as shown in Fig. 20. In the outer row of all, the tubes are

FIG. 20



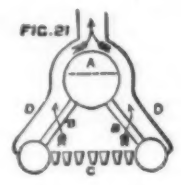
bent at the lower ends, so that, while sufficient space is left between the holes in which the tubes are set, the outer tubes are brought in to stand in the spaces between the tubes in the next inner row. In this way is built up a side sufficiently furnace gas tight for all practical purposes, and yet weighing only 10 lb. per square foot; we say 10 lb. because the outer surfaces of the tubes are of no steam making value, but none the less do they weigh 5 lb. per foot.

Turning to the steam drum and water legs, it will not be safe to make these less than ⅜ in. thick, and they are of no value at all, or of but doubtful value as steam makers in any part of them. But it is clear that, being cylindrical, and having a considerable surface available for fixing tubes in, they are about the lightest possible structures that can be provided for the purpose. But, nevertheless, there are opportunities for saving weight afforded in the matter of flanges, manholes, covers, and connections. The express boiler ought to have no flat surfaces. A flat surface cannot be made so strong to resist pressure as a cylindrical surface, weights being the same.

But when we have settled this point, another arrives for consideration, namely, the weight of water in the boiler. Let us assume that we want 1,000 ft. of heating surface, which should give with very great ease 500 indicated horse power. Let us suppose that every foot of surface is covered by 1 in. of water; we have then 144,000 in. of water, weighing 5,187 lb., or about 2½ tons. The heating surface at 5 lb. per foot will only weigh 5,000 lb. These figures will suffice to bring home to our readers that in express boilers the weight of the water is a very important item. We have here, for boiler and water together, a minimum weight of say 4½ tons as the least conceivable—not by any means the least possible—for the water legs and steam and water drum have to be added, and these will not only weigh a good deal, but will hold much water. The water legs must have enough diameter to allow the tube roller to be used as we have already described; and it may even be found worth while to put into each a second empty tube, to act as a displacer, and so save the weight of so much water. A tube 10 ft. long and 10 in. in diameter will itself weigh between 600 lb. and 700 lb., and it will hold over 700 lb. of water. It is easy to see how rapidly weight mounts up.

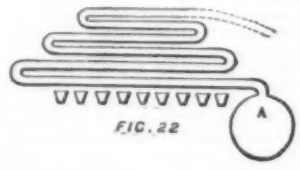
But we have not yet done. Let us suppose that our tubes are all disposed in the simplest possible way, as in Fig. 21. Here we have the steam drum, A, the

FIG. 21



evaporating tubes, B B, the grate, C, and the outer covering, D, taking the smoke to the chimney above. This is all very well, but the ends of the boiler, or rather of the furnace, have to be made up. How, and with what? If we use fire brick, it is clear that we have to put in gable ends, so to speak, of that material, and as these must be thick—for they are exposed to a furious assault from the furnace—and will have to be set in some kind of iron frame, they will be very heavy. For this reason some few inventors have proposed to make the ends up with heating surface, which, if not lighter than the brickwork, would at all events be of use. One scheme is to place at the back end a tube of the shape shown in Fig. 22. In this, A A are the two

FIG. 22



water legs. The pipe is of copper and used to take the feed water into the boiler. The dotted line goes to the feed pump. There are grave objections to this scheme, which we need not stop to discuss. Again, the outer casing, D, is common to all express boilers, although it may assume different forms and proportions. It cannot be made to weigh less than 5 lb. per square foot, and may weigh a great deal more. It represents an important item, and it is well that it should be kept as small as possible.

It is, of course, impossible within reasonable limits to touch on any but a few of the host of questions which start up in the face of the engineer who sets about designing an express boiler. The problem in its broadest and most recent form takes something like this shape: Given a space 8 ft. long, 6 ft. wide, 8 ft. high, get into this the maximum amount of power, the total weight of boiler with fire bars, water, and fittings, not to exceed 3 tons. Of course, the dimensions available and the weight permissible vary with the purposes to which the boiler is to be put. It may be of small power or it may be of large, one of a number or isolated. We have, we think, said enough to give a general notion of the way in which the design must be attacked. Thus, for example, we have probably made it clear that flat-sided water spaces cannot be used. All the surfaces must be cylindrical, except a few, which are best made dished; and the tubes ought to be of small diameter, because the weight of water varies inversely as the square of the diameter, while the heating surface varies only as the diameter. It is perhaps worth adding the caution that express boilers can only be worked with *pure distilled water quite free from grease*. The notion that tubes can be kept free of scale by the current of water is entirely erroneous; the process of scaling up is only delayed. The scaling is not prevented.

The following tables of coefficients or multipliers may be found useful:

Diameter of tube in inches.	Coefficient.
1·0	0·2631
1·5	0·3926
1·75	0·4580
2·0	0·5234
2·25	0·5888
2·5	0·6543
2·75	0·7197
3·0	0·7854

To use it, multiply the length in feet of the tube of the given diameter by the coefficient. The product is the surface of the tube in square feet.

Finally, it will be seen that we offer no advice as to the best method of arranging the heating surface. That is a matter which every inventor will settle for himself. Indeed, it may be said that it forms the basis of nearly all the patents now being taken out for water tube boilers. In our own opinion the system adopted by Messrs. McBride and Fisher embodies about the best principle that can be used. The products of combustion pass among the tubes, first nearly at right angles to them in the lower part of the boiler, and then go on more or less parallel to them above the fire tile division deck to the chimney. In this boiler the sides of the fire box have to be made up with a fire tile casing, which stands for the gable ends of the Thornycroft and Yarrow boilers, and it would be improved by at least partially filling up the space with tubes rolled into the horizontal water legs at each side.

In conclusion, we would impress on our readers the importance of providing for the delivery of dry steam. No matter how satisfactory in other respects an express boiler may be, if it sends wet steam to the engines, it must be more or less nearly worthless.

BOILERS FOR TORPEDO CATCHERS.

IN the course of the series of articles which has recently appeared in our pages on water tube boilers, we defined an express boiler as one which, while very small and light, would produce a great quantity of steam. In other words, an express boiler is a generator which weighs very little and occupies a small space as compared with normal or well known boilers. The express boiler—using the words in their full significance—is a recent or latter day creation, rendered possible only by the use of distilled water. We have dealt with the subject as though an express boiler must of necessity be a water tube boiler; but it is not certain that this is an invariable rule. Many years ago an exceedingly ingenious boiler was made and patented, we think by Hancock, for use in a steam road carriage. It consisted of flat sheets of metal on which were stamped hemispheres or circular protuberances. These, when the chambers were built up in a frame, abutted against each other, and prevented the chambers from opening when pressure was exerted inside them; the hot gases passed up between the chambers. This boiler was very light and very efficient, and it is quite possible that the idea might be developed in the present day with advantage. Be this as it may, we have no reason to doubt that while a very light boiler may be made not necessarily wholly composed of tubes, the lightest possible boiler must be made of tubes and of nothing else.

It is commonly taken in the present day that, if one indicated horse power can be got out of two square feet of boiler heating surface, the result is very satisfactory. This means an evaporation of about 10 lb. of water per square foot of surface per hour. If it were possible to double this, and get an evaporation of 20 lb. per square foot per hour, the advantage would be so great that it is worth while to do much scheming, and inventing, and experimenting to reach the required end. But it must not be forgotten that in no boiler can all the surface be heating surface; and we might have a boiler which was very efficient in one sense and very heavy in another, because the heating surface bore a comparatively small relation to the whole quantity of metal in the boiler. Thus, for example, a large so-called locomotive boiler—a true locomotive boiler has never yet been tried at sea—weighing under steam 13½ tons, will make steam for a triple expansion engine indicating 800 horse power. This gives nearly 38 lb. per horse power. Two square feet of heating surface in tubes would only weigh 20 lb., allowing one-half their surface to be inefficient. It is easy to see that the best result cannot be got out of a locomotive boiler. There is far too much flat surface to be stayed. About the maximum performance for this type has been got, we think, by a Thornycroft boiler, which evaporated 10,840 lb. of water per hour. The total heating surface was 620 square feet; 78 lb. of coal were burnt per square foot of grate. But the air pressure in the stokehold reached 6 in. of water. The evaporation per square foot of heating surface was very nearly 17·5 lb. The total weight of the boiler without fire bars could not have been much short of five tons. Taking the power as 500 horses, we have 22·4 lb. of boiler per horse power. This does not include fire bars or other adjuncts, and the work is too severe to be long continued in that spe-

* From the *Engineer*, London.

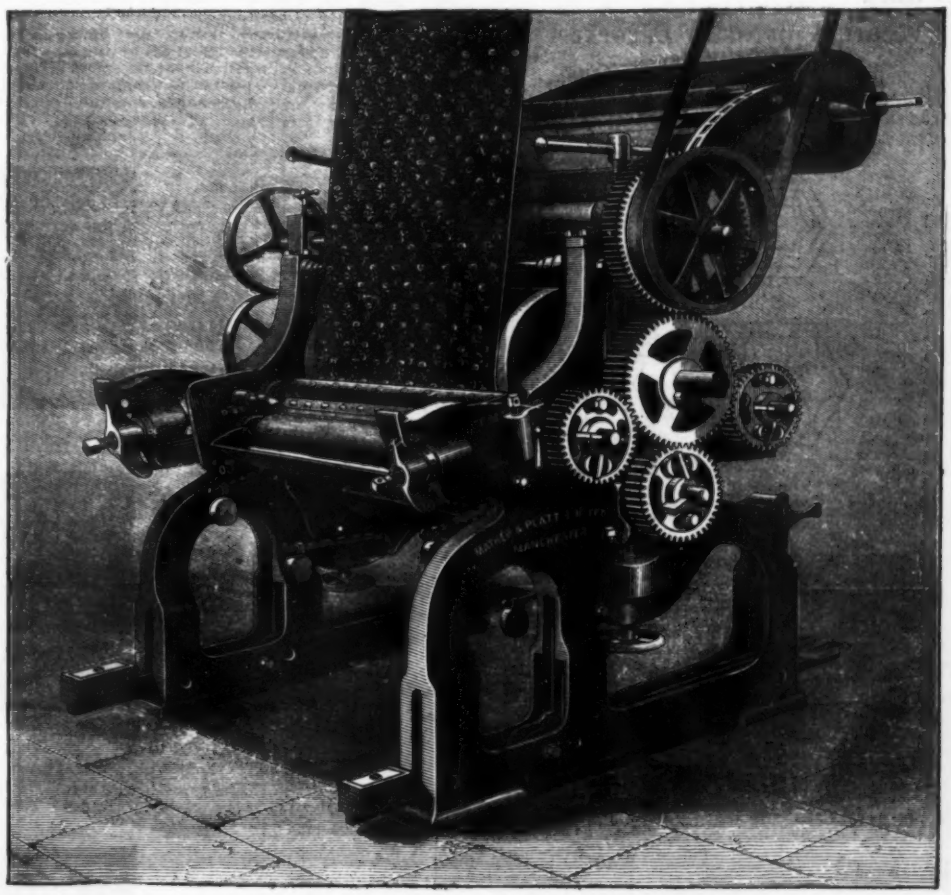
cial type of boiler. Reverting, then, to tube surface, we have to consider how it shall be used. The first essential is that both sides—in other words, the whole surface—of each tube shall be fully heated, and not one side only. The next is that care shall be taken that an ample supply of water shall invariably be provided to take up the heat. If we have a long tube of small diameter, say an inch, and a very fierce heat, so much steam may be made in the bottom of the tube that all the water above will be blown clean out of it. Then water will rush in from below or above to fill the space, and this in turn will be ejected. We could name more than one water tube boiler which behaved in this way when hard pressed. The makers called the action "circulation," but it was not circulation in the legitimate sense of the term; a boiler worked in this way will soon be burned out and cannot fail to prime heavily. This "gulping" action is exceedingly injurious, and to be strenuously avoided. Bearing in mind the stipulation that the whole surface of each tube shall be heated, it will be seen at once that it is expedient that the tubes should be short. It is also evident that they must either be vertical or very steeply inclined. Any approach to the horizontal will result in disaster unless the tubes be very short and at least 2 in. in diameter. It may be taken as a rule that the fiercer the heat, the more closely should the tube approach the vertical.

Experiment goes to show that so long as a tube is made of metal not too thick, and abundantly supplied with water, it is quite impossible to burn it. We have already in a former impression cited Mr. Maxim's experiments in this direction. Years before Mr. Maxim thought about flying machines, Mr. Pope carried out experiments with tubes made of common tin plate soft soldered. These were buried in a blacksmith's fire, and everything possible was done to destroy them, but fire capable of putting a welding heat on a 3 in. bar could not melt the soft solder on the tube. We may take it for granted, then, that we cannot produce too hot a furnace. In this direction, no doubt, torpedo boat builders have proceeded a long way, and when 70 lb. or 80 lb. of coal are burned per square foot of grate per hour the temperature is very high. But something still higher can probably be got with petroleum. The maximum temperature to be had with proper arrangements and oil fuel will probably suffice to melt fire bricks of good quality much like sealing wax. If, now, there is practically no limit to the rate at which water will take up heat, it seems to be not at all improbable that an evaporation of 20 lb. or 25 lb. of water per square foot can be had. The notion that the water will be driven away from the tube surface and assume the spheroidal condition has no foundation in fact. But very great care must be taken to prevent the clinging of steam to the surfaces. An evaporation so rapid means, as far as the tubes go, only 5 lb. of boiler, and allowing 5 lb. more for the rest of the boiler, and other 5 lb. for water, we have 15 lb. per horse power, or for 800 horse power 12,000 lb., or say 5·5 tons, instead of 13·5 tons; and allowing a ton for fire bars and funnel, we still have a boiler which gives us 100 to 120 horse power for considerably less than a ton. That such a boiler can be produced we have no doubt. That it has yet been made we doubt, although results of trials made in the United States seem to show that engineers have got within measurable distance of it at the other side of the water, and on a comparatively small scale. The boiler of the Yankee Doodle is said to have 300 square feet of surface, and to weigh only one ton under steam. Fig. 14 *ante* illustrates it. It will be seen that we have made a tolerably liberal allowance of steam per horse per hour, and certain very excellent performances accomplished in this country are more to the credit of the engine than the boiler—a fact not to be forgotten.

If our readers will examine the designs of any express boiler, or will set about scheming one themselves, they will quickly find that there is a great deal of surface—in other words, a great deal of steel plate—that is of no use for generating steam. Not only does this weigh, but it takes up room which can ill be spared. Let us suppose that we use vertical tubes 3 ft. long; under them come the feeders, say 1 ft. in diameter, and above them the receiver, say 2 ft. in diameter. As the feeders must be below the grate level, there is less than 3 ft. left between the grate and the bottom of the receiver, and even then the whole boiler is at least 6 ft. high. The steam receiver and separator over the fire is the great offender. If it could be suppressed or put in another position, considerable advantage would be gained as regards height. It is held, of course, that it is essential in order to get dry steam. If it satisfied this condition, and if nothing else would satisfy it, then we must perforce have it. But it may be shown that the horizontal cylinder of considerable diameter, lying along the top of the boiler, is not necessarily the only expedient by which dry steam may be got, and that, in point of fact, unaided it will not give dry steam at all. There are various ways in which steam may be dried without the use of an unwieldy and heavy cylinder holding a great deal of water. It is true that each steaming tube must deliver a very large quantity of water mixed with steam. The steam can scarcely fail to fill the whole diameter of a 1 in. tube, and in any case its upward rush will entrain much water. If the tubes deliver against a flat plate, the concussion will knock much of the water out of the steam, and various devices are available for getting rid of the remainder.

It must not be forgotten that all we have just written applies to a very special and peculiar type of generator, in which a great deal is sacrificed for the sake of getting the largest possible quantity of steam out of the smallest and lightest possible boiler, and it is not to be expected that such a boiler can compare in economical efficiency with others. If we took an ordinary railway locomotive boiler and cut most of the barrel and tubes off, we should have a very efficient generator left, but it would not be very economical. Let us suppose, for example, that we burned 80 lb. of coal per square foot per hour in the grate; that the boiler tubes were 12 ft. long; and that a certain weight of water was evaporated per hour. If, now, we cut away all the barrel, save enough to leave tubes 2 ft. long, then the evaporation would still be nearly 75 per cent. as great as before. There would be a loss in economy of fuel, but there would be an immense saving effected in weight and in space. Furthermore, the reduction in the length of the tubes would permit us to reduce their diameter, and the economy and efficiency of the boiler would both be helped by that alteration. There is, indeed, no reason to suppose that an express boiler must be dreadfully uneconomical; but, on the other hand, any attempt to make it thoroughly economical will end in failure, unless indeed it is intended to use the boiler only for very short periods, in which case the spaces for the discharge of the products of combustion may be made contracted, but only by incurring the risks of sooting them up and ruining the draught.

There are, we have no hesitation in saying, possibilities in view which, made use of properly, will give us boilers of hitherto unrealized lightness and smallness. The principles to be observed are very simply stated. The first is that the heating surface, and indeed the whole boiler, shall be as far as possible tubular. The second is that every inch of surface not used for generating or drying steam shall be regarded as waste. The third is that great care should be taken to secure a regular discharge of steam from the heating surface. If the steam has any chance of hanging or clinging to the metal, disaster will follow. When we come to work with enormous temperatures, there is no time for the correction of an error. If, for instance, a tube should boil itself dry, in less than five seconds it would be white hot and would burst. Fourthly, special arrangements must be made for getting the water out of the steam. To comply with all the requisite conditions is very far from being a simple matter. So much has been done, however, that more can no doubt be done, and we do not despair of seeing a boiler which, complete, shall only weigh about 15 lb. per horse power, and nevertheless shall be sufficiently durable to satisfy all legitimate demands that can be made on a torpedo catcher.—*The Engineer.*



THREE CYLINDER CALICO PRINTING MACHINE.

CALICO PRINTING MACHINERY.

By JOHN WATERSON.

ALTHOUGH the two cylinder vertical engine is the one which is the most popular for driving the calico printing machine, the three cylinder engine appears to be regarded as the best for this purpose. The general appearance and arrangement of the printing machine can be seen from the extremely good illustration, representing Mather & Platt's three color machine. In any printing machine the frame should be strong and massive, in order to stand the great pressure put upon it without springing, and it should be well bolted to an absolutely firm and unyielding foundation. The side blocks, holding the bearings of the printing rollers, should be long, and plenty of adjustment allowed in all the moving parts.

Every part of the machine should be thoroughly well made and finished and the fitting accurate. As the pressure on the bearings of the rollers is heavy, they must be kept well lubricated—tallow, or tallow mixed with finely powdered plumbago, being the best lubricator. When the bearing becomes too warm it is a very common practice to hang a continuous loop of cloth on the end of the roller that projects out, and immerse the lower end of the loop in a vessel of cold water. The revolving roller turns the continuous band of cloth and thus a fresh part, impregnated with cold water, is constantly brought into contact with the heated roller; hence the bearing is kept much cooler.

The color boxes are supported underneath the printing roller on wooden or iron stands, which can be raised or lowered by screws. When the box is put in the machine the support is dropped, the color box put in and adjusted to exact position by means of the regulating screws. The furnisher is held in brass or gun metal bearings, fixed on the ends of the color box, and is driven by means of a toothed wheel, gearing into a similar wheel fixed on the end of the mandrel carrying the engraved copper roller. Thus it works generally at the same speed, or in some cases faster than the printing roller; many people are of the opinion that the furnishing roller should run about one-third slower than the printing roller. When it is required that the furnisher should travel in the opposite direction to that in which the pattern roller is going, a small toothed wheel, called a stud or stud wheel, is placed between the wheels on the ends of the furnisher and the print mandrel. This is nearly always done when printing colors contain large quantities of solid matter in suspension, such as all the pigment colors, and several other colors, that are liable to "stick in the engraving"—very often because it has not been there at all.

The engraved copper roller or shell is forced on to a wrought iron mandrel, which fits the bearings on the printing machine. The mandrel has a projecting tongue or "tab" which runs from one end to the other, and it fits a corresponding groove in the printing roller; thus the latter is prevented from turning on the mandrel.—*The Dyer and Calico Printer.*

THE SWORD OF ETHAN ALLEN.

By JOHN R. WEATHERS, Washington, D. C.

THOSE interested in the early events of our country, and especially those who are thrilled with patriotic emotion at the stories of valor and devotion found in the history of the American revolution, will be pleased, I am sure, to know that the old sword of Colonel Ethan Allen is still preserved. The writer saw it recently in the National Museum, of this city.

The sword is an old-fashioned blade about twenty-seven inches in length and slightly curved. The handle is made of horn or bone, and is some seven inches long, making the total length, from tip to tip, about thirty-four inches. The mounting is of silver, marked with gold, but the latter is partially worn off. A dog's head of silver forms the end of the handle, and from this to the guard runs a silver chain. On one of the silver bands of the venerable leathern scabbard is the name "Ethan Allen" engrossed in large letters; on another band, "E. Brasher, Maker, N. York"; while on a third band appears the name "Martin Vosburg, 1775." What connection this last name has with the sword, no one seems to know.

Colonel Ethan Allen, the original owner of this sword, and whose fame has made it valuable and renowned, was born in Litchfield, Conn., January 10, 1737. He was active, patriotic and brave, and hated tyranny. Soon after the noted battle of Lexington, Mass., in the American revolution, Ethan Allen was requested by the General Assembly of Connecticut to enlist men and capture Ticonderoga, a strong fort in the State of New York, then held by British troops. He immediately raised 230 "Green Mountain Boys," and with them took the fort, in the early morning of May 10, 1775.

In describing the assault, and the part the illustrious sword played in the capture, it is, perhaps, best to quote from Colonel Allen's memoir.

"At the time of the assault," says the colonel, "a British sentry made a pass at one of the American officers with his bayonet, and slightly wounded him. My first thought was to kill him with my sword; but in an

instant, I altered the design and fury of the blow to a slight cut on the side of the head, upon which he dropped his gun and asked for quarter. This I readily granted him and demanded of him the place where the commanding officer kept. The sentry showed the way. The British commander asked me by what authority I demanded the surrender of the fort. I answered him, 'In the name of the Great Jehovah and the Continental Congress!' The authority of Congress," continues the colonel, "being very little known at that time, he began to speak again, but I interrupted him, and with my drawn sword over his head, I again demanded the immediate surrender of that garrison; with which he then complied."

The fort, the garrison, and about one hundred pieces of cannon were the result of this easy victory.

Colonel Allen died in Burlington, Vt., February 13, 1789, at the age of fifty years, leaving his sword to his son, Captain Hannibal M. Allen. At the death of Captain Allen, the famous blade was retained by his widow, Agnes B. Allen, who became a member of the family of her sister, Mrs. Benjamin Hopkins. But upon the marriage of her favorite nephew, Hannibal Allen Hopkins, she made her home with him for the last twelve years of her life. At her death, in 1863, the sword became the property of Hannibal Allen Hopkins; who, dying in 1871, left it, in turn, to his widow. This widow died a few years ago at Lansing, Mich., and the coveted sword passed into the hands of her son, Hannibal Allen Hopkins, Jr., through whose courtesy it has been loaned to the United States government and placed beneath a beautiful case in the National Museum, of this city.

This precious relic is a silent reminder of the great struggle through which our forefathers passed, for the overthrow of political tyranny and the establishment of a home for freedom and untrammeled intelligence.—*Education.*

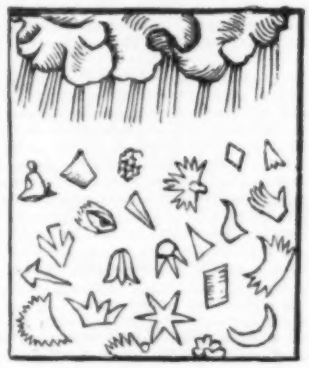
STUDY OF SNOW CRYSTALS.

By Prof. Dr. G. HELLMANN.

(Translated for the SCIENTIFIC AMERICAN.)

IN ancient and mediæval writings we find the form of the snow seldom mentioned. It was quite natural that little attention was given to snow figures in ancient times, for the people of culture, who lived around the Mediterranean Sea, had rarely an opportunity of observing them. As might be expected, the earliest observations upon snow crystals were made by the people of northern Europe.

Albertus Magnus was probably the first one to call attention to the star-shaped form of the snow. The celebrated work of the learned Archbishop of Upsala, Olaus Magnus, which appeared at Rome in the year 1555, under the title of "Historia de Gentibus Septentrionalibus," contained a chapter on snow crystals, and likewise the first delineations made of them. On account of the great interest attending this first attempt to produce representations of snow crystals, a fac-simile is given. The author remarks in the text that the nearer one approaches the north pole, the greater is the abundance of snow figures. In one day fifteen, twenty, or even more different forms may be observed.



OLAUS MAGNUS, 1555.

He attempted to point out these varieties plainly in his drawings, but he undoubtedly allowed much play to his imagination, for hardly any of the figures correspond with those forms which actually appear in nature.

Although Olaus Magnus first called attention to and delineated the variety of snow figures, he overlooked the hexagonal form, which lies at the foundation.

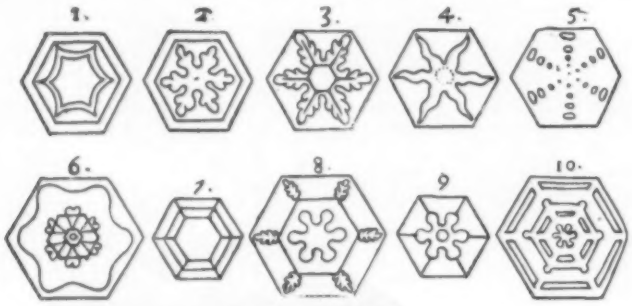
Kepler published, in the year 1611, the first book on snow crystals, "Strena seu de Nive Sexangula." Its purpose consisted not so much in describing new forms of snow crystals as to call attention to their hexagonal form. "Cur autem sexangula?" asks Kepler. He sought to establish various hypotheses which could not be maintained, assumed for each substance a peculiar forming or shaping power, and left the real solution of the problem to the chemist, who should say whether any salt or what kind was contained in snow.

The French scholar, Fabri de Peirese, expressed his opinion, in the year 1623, that snow originated from seed, as plants.

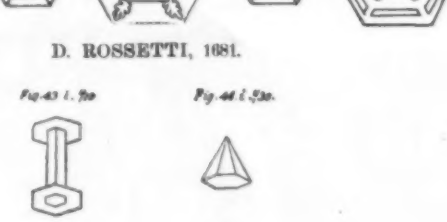
The observations upon snow figures published by Descartes, in the year 1637, show a slight advance.

The Danish mathematician and physicist, Erasmus Bartholinus, published in 1660 "De Figura Nivis," which contained drawings of snow crystals. For the first time somewhat complicated forms are represented. Bartholinus certainly erred in his drawings, as he failed to draw the secondary rays parallel to the principal rays. We are not informed whether this scholar used optical help in his observations.

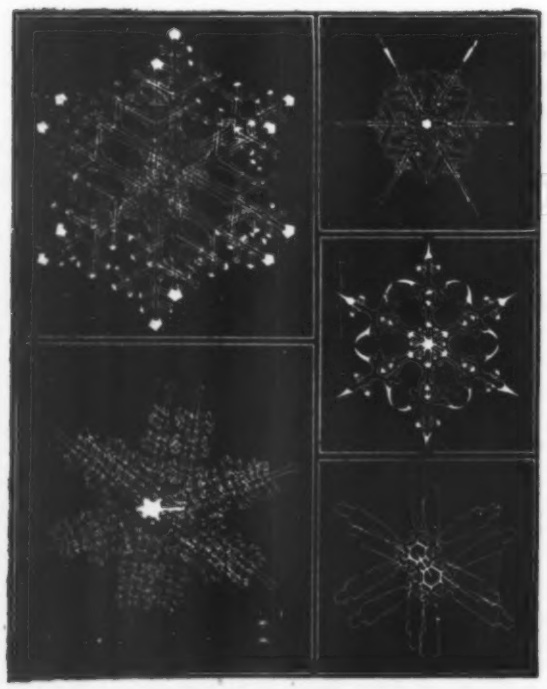
The English physicist, Robert Hooke, was the first to investigate the structure of ice, hail, and snow, by means of the microscope. His famous work, "Micrographia," contains a selection from more than a hundred forms observed by him. He has happily avoided the error in drawing of Bartholinus, for the conformity to law was known to him ("the branchings from each side of the stems were parallel to the next stem on that side"). In the year 1675 we obtain for the first time information in regard to snow crystals in the Arctic regions, through the German traveler Friederich Martens, of



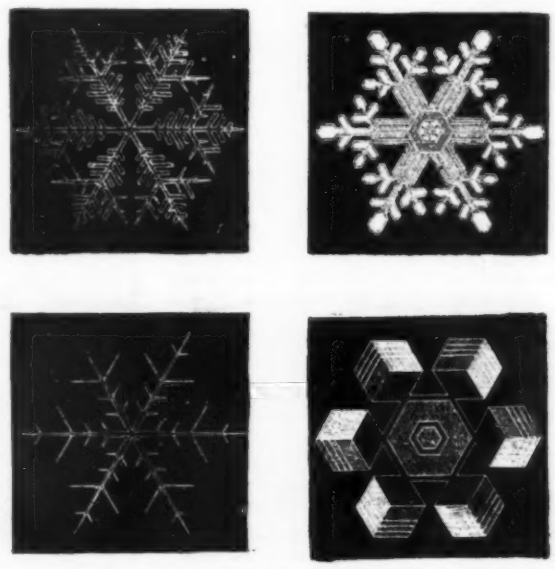
D. ROSSETTI, 1681.



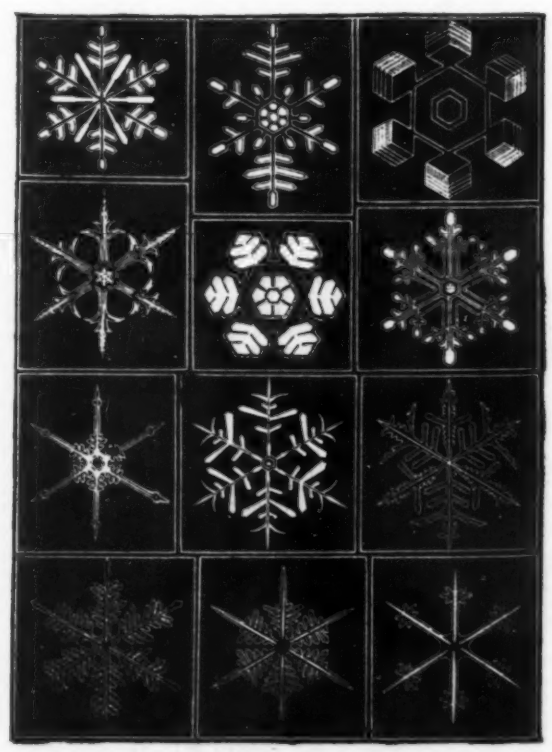
W. SCORESBY, 1820.



DRAWINGS BY J. GLAISHER, 1855.



DRAWINGS BY J. GLAISHER, 1855.



DRAWINGS BY J. GLAISHER, 1855.

Hamburg, whose great service in the exploration of Greenland and Spitzbergen is little known even in his own country. His delineations of snow figures lay more claim to our interest because he leads us step by step in the progress of the formation of the snow crystals, and accurately notices the state of the atmosphere in which they make their appearance.

The next important research leads us from the north of Europe to southern Europe, upper Italy. Donato Rossetti, a canon of Livorno, had, during his residence of six years as mathematician at the court of Turin, made a close study of snow crystals. He published his researches in 1681. The book seems to have been forgotten, yet it deserves our attention, for it contains an excellent collection of drawings of small, plate-shaped crystals, and the first attempt at a systematic classification of them into various types. Rossetti divided these crystals into five distinct classes: Bruscolo (blade of straw), Fiocco (flakes), Punto (points), Rosetta (rosettes), and Granello (globes). He gives some sixty different snow figures in his illustrations. A fac-simile is given of the first ten figures of the class Rosetta.

The comprehensive work of the Holland physician, Jan Engelman, deserves especial attention. It contains twenty-eight plates, showing four hundred and twenty snow crystals, observed by him during the hard winter of 1740. Many of Engelman's figures deviate so much from the hexagonal system that it must be assumed as an error in observation or drawing. His book, which contained more theology than physics and meteorology, found such favor with the public that, twenty-four years later, a second edition was published. Just as improbable are many of the representations of snow figures in the "Hydrologie" of the Swedish scholar, J. G. Wallerius, who, in his over-zeal to systematize all water, whether flowing or frozen, stated that there were ten different species of snow. Somewhat later, we have the investigations of his countryman, J. R. Wilcke, which are of great interest, because he was the first, to my knowledge, to produce snow crystals artificially.

In the year 1820 the English whaler later the theologian, William Scoresby, published "An Account of the Arctic Regions." The keenness of his observations, and the excellence of their reproduction in ninety-six figures, the clearness of his statements, and the successful attempt to classify the crystals under five heads, have given to Scoresby's idea of snow figures the widest reputation. There is scarcely a text book on physics or meteorology which does not more or less fully describe Scoresby's classification, and give some of his illustrations. His classification is as follows: 1. Lamellar. 2. A lamellar or spherical nucleus, with spinous ramifications in different planes. 3. Fine spiculae, or six-sided prisms. 4. Hexagonal pyramids. 5. Spiculae, having one or both extremities affixed to the center of a lamellar crystal. Of class 4, hexagonal pyramids, he says: "This kind of snow crystal I have seen but once. These pyramids were about the thirtieth part of an inch in height, and fell along with some other curious figures, during a fresh gale of wind from the northward, in

Fig. 1a.

very large quantity." Figs. 44 and 47 represent this kind of crystal. Of the last class he says: "This is the most singular genus I have ever seen, and has been observed but twice. It resembles a pair of wheels united by an axletree; the wheels consisting of hexagonal or other lamellar crystals, and the axle of a slender prism. Figs. 43, 45, 46 and 48 represent this modification of snow crystal. These figures were principally seen in a quantity of snow which fell on the deck of the ship in which I sailed. The temperature when this kind of crystal fell was in one instance 22° and in the other 20°." The fraction seen beside the numbers of the figures gives the diameter of the snow crystals in English inches. Scoresby believed that the form of the snow crystals depended in a certain degree upon the temperature of the air. The French mineralogist, Guettard, discovered this in 1762. In 1838 Karl Fritsch, of Prague, spoke of this, but in his "Observations" published in 1853, remarked that these relations were doubtful. The beautifully executed representations by James Glaisher, the English meteorologist, which are given, are little known because they were only published in a report of the British Meteorological Society for 1855. Glaisher sketched in four weeks more than one hundred and fifty different snow figures, which his wife copied with the greatest care, and completed according to the fundamental laws of symmetry. These drawings represent snow crystals in an ideal purity, delicacy and perfectness as nature never presents them to the human eye. It might be possible thus to see a single snow crystal at the moment of its creation, but we seldom obtain a sight of them in this state. I found out after many years of painstaking investigation that it was impossible to make accurate drawings of snow crystals as they really appear, and, therefore, greatly desired to procure photographs of them.

Dr. Neuhass, in the winter of 1892–1893, made some photomicrographs of snow crystals, in Berlin, which he very kindly placed at my disposal. I have made a selection from them and have reproduced Figs. 1 to 12. In the latter part of the year 1892 some of these photographs were photo-engraved for the *Scientific Journal of Microscopy*. These are to my knowledge the first micro-photographs of snow crystals ever published. Herr Nordenskiold made microphotographs of snow crystals about this time in Stockholm, which were published in March, 1893. Dr. Neuhass says he used a Zeiss projecting microscope, 31 mm. focal distance, and a small petroleum lamp as a source of illumination. He gave an exposure of 5 to 7 seconds, using Sachs orthochromatic plates. Although the lamp was placed 80 cm. from the objective table, and the image of the light was projected a few centimeters behind the focal plane, by means of an illuminator, and in spite of a temperature of —5° to —10° R. the heating of the object was such that the crystals began to melt in a few seconds. After the insertion of a cell filled with a solution of alum they remained unchanged for a little time. The alum solution froze at —5° R., and could only be kept in a fluid state by the addition of a quantity of salt.

A great difference can be distinctly perceived between these photographs and the drawings of Engelmann, Nettis, Wilcke, Scoresby and Glaisher. At first, perhaps, we will not be inclined to give preference to the photographs. We miss the absolute regularity and perfect symmetry which are found in the drawings. But herein lies the superiority of the photographs. We have now no longer ideal forms and

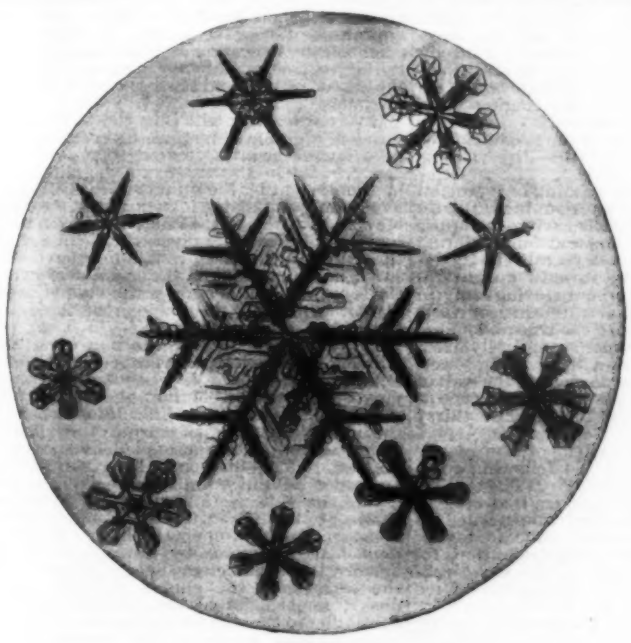


Fig. 1.

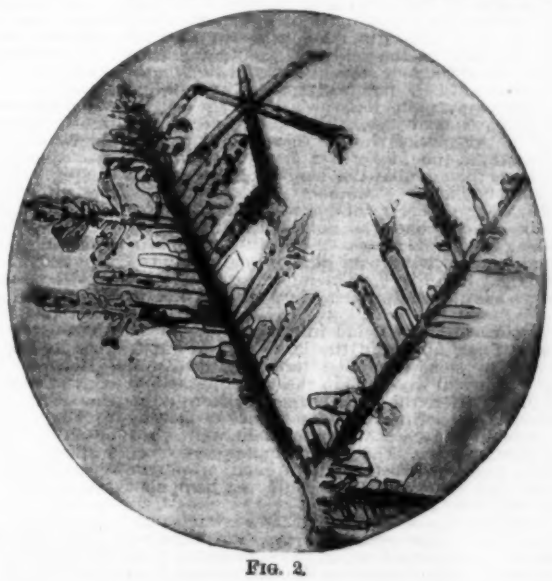


Fig. 2.

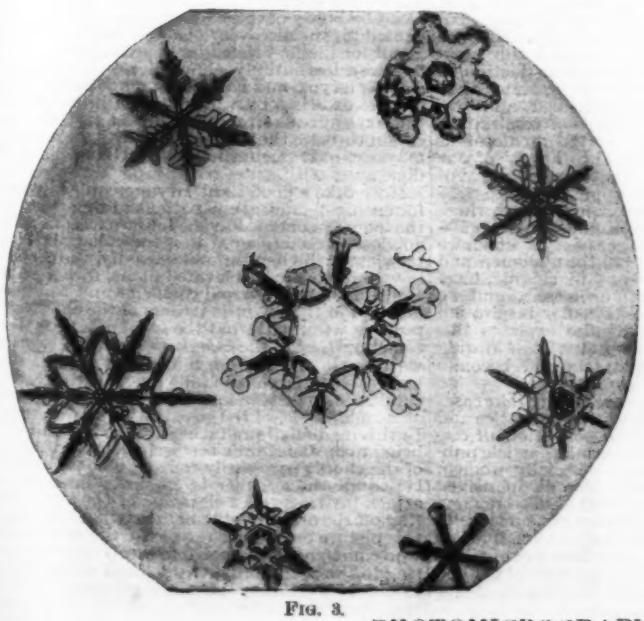


Fig. 3.

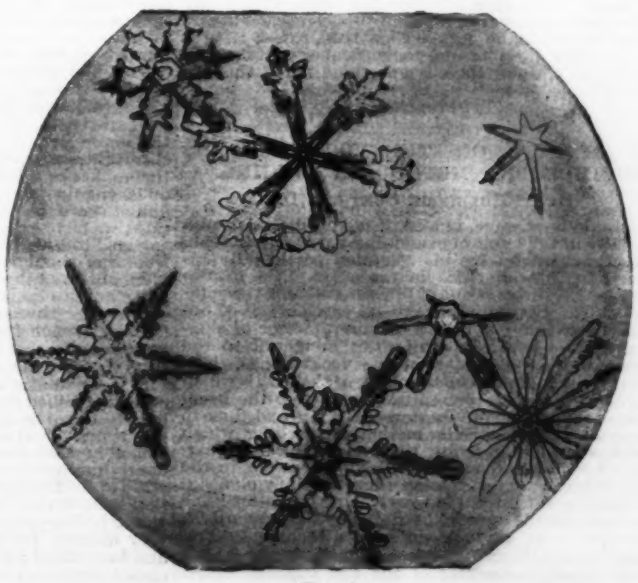


Fig. 4.

PHOTOMICROGRAPHS OF SNOW CRYSTALS.

perfectly symmetrical figures before us, but real images as nature offers them to us.

The deviations from the regular geometrical forms and the irregular and unsymmetrical forms may be due chiefly to two causes. First, snow crystals in their regular formation are frequently destroyed in the beginning. They meet with many disturbances on their way to the ground, from their place of origin. We know from all the theories of crystallization that regular crystals can only be formed when the active molecular powers can work unhindered in all directions. Now, if these conditions were fulfilled in the atmosphere, if, in their state of equipoise, there prevailed even one gentle motion, as is well known, it would expedite the separation of the crystals at the moment of crystallization. It is frequently the case at the time of snowfalls that the upper stratum of air is in violent motion. Even when it is very calm on the surface of the earth it is more or less windy in the region where the snow crystals are formed. So it is due to the wind that the first irregularity in snow crystals is brought about. The experience of investigators confirms this statement, because, in the calmest weather, the most beautiful and regular snow crystals may be observed. The second cause of irregularity is the disturbance of the snow figures by falling to the earth from their place of origin. The injury which the crystals inflict upon one another by coming into collision is naturally greater in a strong wind. The probability of such injury is lessened when the crystals are formed at less height, and, consequently, have a shorter distance to travel over when falling. Observation confirms this, for when, upon low-lying vapor or mist, through which the blue sky may be seen, isolated snow crystals separate, they are especially regular in form. This occurs very rarely with us, but it frequently happens in the polar regions.

There are three kinds of irregularity which lay claim to our attention, viz.: Incomplete development, injured crystals, and unsymmetrical crystals.

Our photographs not only show that these anomalies exist, but they may also be shown by measurement, which has been quite impossible heretofore with drawings of snow crystals.

An accurate measurement of the snow crystals contained in Figs. 1 to 12 shows that only four are quite regular—the beautiful star at the lower edge of Fig. 1, the small hexagonal plate at the upper edge of Fig. 9, which has a diameter of only 0·3 mm., the hexagonal plate on the lower edge of Fig. 9, whose three diameters are 0·782, 0·790, 0·745 mm. in length, and the star-shaped plate at the upper edge of Fig. 11, with the diameters 1·985, 1·985, 1·935 mm. All the other figures show a much greater difference in their dimensions. With the ray-like stars, the rays are frequently of unequal length. Plate-shaped crystals have often unequal sides. Of the hexagonal plate-shaped crystals with unequal sides, there are two distinct types, oblong hexagonals, with two long parallel sides and four shorter sides, and hexagonals of which the alternate sides are of equal length. An example of the first kind may be seen in the center of the large star in Fig. 5, and also in the four stars in Fig. 6, with a plate-shaped spreading of the points of the rays. In all five cases the hexagonal plate lies eccentric to the central point of the principal star. The difference in the length of the longer and shorter sides may be plainly seen in the star at the top of Fig. 6, where the longer sides are more than double the length of the shorter sides (0·4 and 0·19 mm.)

Of the earlier observers of snow crystals, Rohrer seems to be the only one who noticed and illustrated these oblong hexagonal plates. A beautiful example of the second kind of hexagonal plate is shown in the crystal at the left in Fig. 8. The inner hexagonal with sharp edges has alternate sides of 0·9 and 0·7 mm. in length.

Deformations are to be found in almost every plate. The most striking appear in the large star in Fig. 1, where probably some external interference displaced one of the principal rays, and in the upper hexagonal plate in Fig. 8. Here the inner hexagonal shows a distinct deformation, perhaps in consequence of melting on one side in the state of development, and subsequently forming anew. This or any similar occurrence must have happened before the formation of the secondary rays, otherwise they could not have shot out so far from the principal ray.

In all the drawings of star-shaped snow crystals published until now, the secondary rays, starting from each side of the principal ray, at the same point, have been of equal length; wherefore the figures have been perfectly symmetrical. In reality this is not always the case. The secondary rays are often unequal in length, and are not always exactly opposite each other, as may be seen in the stars in Figs. 1, 1*a*, 2, 5, 6, 11, and 12. Another form of unsymmetrical crystal may be seen in Fig. 6, where there is a combination of the star and plate.

(To be continued.)

THE EFFECTS ON THE VOCAL CHORDS OF IMPROPER METHOD IN SINGING.*

By H. HOLBROOK CURTIS, M.D.

It would be strange, indeed, if a laryngologist who was daily in the habit of examining very many throats of singers did not have his attention particularly attracted to the difference in the appearance of the glottis as the direct result of different methods of voice production. Several years ago—as early as 1884—I observed that many pupils of a certain professor of singing presented marked peculiarities in regard to the position of the free borders of the vocal bands. The slightly elliptical shape of the chink of the glottis which this class of pupils presented in emitting the usual sounds to allow the proper view of the larynx led me to inquire as to the particular method of teaching which would produce in so many throats a typical appearance. I soon found out that these pupils were in the habit of taking daily exercises almost entirely on a single vowel, and that single vowel being the letter "O." The vocal chords appeared striated, with frequently a congested area at their anterior attachment. Frequently a nodule, more or less defined, would be observed about the center of the free edges on either chord; this is a picture which every laryngologist will recognize. Another type, of which the study is most interesting, is that of a class of pupils undergoing instruction at a conservatory where that pernicious French method, the so-called stroke of the glottis (*coup de glotte*), is daily practiced. In this type the writer has observed the middle third of the chords to be slightly bulged, the chords presenting a convexity in contradistinction to the concavity exhibited in the last group. These pupils had been singing chiefly on the vowel "A," pronounced as "ah" in English, and with the emission of each note the middle portion of the chords would clash, and, by constant attrition, become hardened and callous. The chords in this particular type do not usually show congestion; their appearance is usually of a good pearl color and healthy looking in every way. The complaint which they make upon consultation is a difficulty in singing the so called *mezzo voce* and a lack of richness of tone and *timbre*, with extreme weakness of two or three notes in the upper-medium register. It was these two opposite appearances of vocal chords, which are every day observed in singers' throats, that led to an investigation of methods employed by the various schools of singing, and has opened up a field which I think has been entirely neglected, though of the greatest importance to every laryngologist who has to do with the singing voice.

Two names are intimately linked with the traditions of method in singing—those of the elder Lamperti (that illustrious exponent of the best Italian school) and Mandl, who, by his ingenious arguments, though founded on a false physiological basis, succeeded in completely overturning the art of voice production which previously had been taught throughout Europe. He substituted in place of the so-called Italian school a method of abdominal respiration, which was at once adopted in the Paris conservatory and has obtained to within the last three years an almost universal recognition in the best schools of the Continent.

It is the writer's purpose, without going too deeply into the history of singing, to discuss the various methods of respiration and initial tone production, and to show by a series of experiments made upon individuals the effects of certain methods of voice building, hoping to arrive at some definite conclusion as regards the proper exercise and position of the larynx, and consequently proper tension of the vocal chords during tone emission. For the brief historical sketch which I shall give I am indebted almost entirely to the able article article of Dr. Joal, of Mont Dore, which appeared in the *Revue de laryngologie, d'otologie et de rhinologie*, Nos. 8, 9 and 10, Paris, 1892. The position which Dr. Joal occupies at Mont Dore (the favorite resort of almost all the European artists) has enabled him to consult freely for a number of years the most distinguished vocal talent in Europe, and his views upon voice production should be carefully read by every instructor who wishes to profit by the exceptional opportunities which that author has enjoyed. One cannot read his able discourse upon the singing voice without feeling that his every utterance is *ex cathedra*.

In 1842 Beau and Maissait divided the respiration of singers into three characteristic types—the superior costal, inferior costal and abdominal. The superior costal may be illustrated as the breathing of a woman tightly laced, the respiratory expansion taking place chiefly in the cone of the thoracic cavity, the upper ribs, collar bone and sternum rising and falling during the respiratory act. In the inferior costal type the inferior ribs (commencing with the seventh downward) are rotated and elevated, the sternum moving only in its inferior portion, the abdominal wall being contracted during the inspiratory act. In the true abdominal type the thorax is supposed to remain completely fixed, the diaphragm taking the ribs as a fixed point, lowering the abdominal viscera, thus distending the wall of the abdomen in inspiration. It is this latter type of breathing which has been taught for the last thirty years in France.

Mengozzi, together with the masters of one of the conservatories, determined upon the following rules illustrative of the breathing of singers: "The respiratory act in singing differs somewhat from that used in speaking. In speaking the abdomen is distended in inspiration and recedes in expiration, while in singing the abdomen must be drawn in during inspiration, returning slowly to its natural state as the chest contracts in expiration, thus retaining as a negative force the air which has been introduced into the lungs."

In a revision of this method, published in 1866 by Baptiste, these laws are repeated, with the addition of a note by Dr. Mandl (the apostle of abdominal respiration), who advocates the advancing of the abdomen in inspiration. Mandl carried his point and his ideas became generally adopted by the conservatory. M. Bonheur and Dr. Cheval, of Brussels, advocated the superior costal type of breathing, in contradistinction to the method of Mandl. Mandl in his work states that the larynx becomes very much depressed and the glottis enlarged in the costal method of respiration. Joal answers him in these words: "We do not find this depression of the larynx referred to in any of our classical treatises on physiology, anatomy or in any of the numerous works which have appeared since 1855 on laryngology; consequently, we suppose that writers do not share the ideas of Mandl on the subject. Besides, we have examined a number of persons whom we engaged to breathe alternately from the abdomen and from the shoulders. We ourselves, in singing, have often observed the movements of our larynx, and we have never observed that the clavicular inspiration caused the thyreoid to fall." Nicaise explains this fact by demonstrating, experimentally, that during strong inspiration the trachea contracts and becomes shorter, which draws down the larynx.*

It is very difficult for a professional man to take cases of distinguished singers in his own private practice and hold them up by name as models of perfection of certain types. Joal made the assertion in an article published in 1890, that great artists, especially women, used the superior costal method. The distinguished critic of *Le Temps* challenged Dr. Joal at once to mention some of these artists. The doctor responded: "I would be happy to gratify Mr. Weber's desire, but it is very difficult for a physician to go into personalities and to say that a certain singer is using a vocal method considered disastrous and execrable by masters of criticism." Melchissedec, however, offered himself as an example of the superior costal respiration, saying that it had enabled him to sing constantly for twenty-five years. Both his strength of tone and tremendous endurance, with an almost perfect glottis, attest that the method has not been injurious to him.

The abdominal method of breathing has many powerful advocates; M. Obin and M. Faure, for example, speak most highly of it; Shakespeare, of London, Behnke, and Lennox-Browne are also its advocates. The instructors of both methods are very apt to quote great artists as the exponents of their particular school. Joal cites the case of Rubini, the celebrated tenor, whom Massini and his pupils declare originated abdominal respiration. Bonheur, on the contrary, states that he expanded his upper chest. Walshe even going so far as to say that he fractured his collar bone in making a violent effort to reach "B flat" in *The Talisman* of Pacini. Lablache and Laget acknowledged that, in spite of long and attentive observation, they had not been able to distinguish in the theater how this illustrious tenor breathed. Joal goes on to state that the famous Lamperti is alternately represented as a partisan or opponent of the abdominal type of breathing, but I think that, having treated many of the elder Lamperti's pupils and interrogated them very particularly upon this question, I may unhesitatingly affirm that the elder Lamperti was a strong advocate of the lower costal respiration, always arguing that the abdominal wall should remain quiet, or should be slightly drawn in during inspiration. The evidence of Campanini, Jean de Reszke and Clara Heyen is in support of the foregoing. Joal says if we except the works of Laget and Bonheur, we find nowhere the praise of clavicular breathing in men. The ancient method of the Paris conservatory and the works of Maunstein, Caruth and Manuel Garcia, all advise thoracic respiration by the elevation of the ribs and drawing in of the abdomen.

If we take up any work on the voice and study the photographic appearances of the chords during the emission of certain notes, we remark that the chords are not vibrating longitudinally, but that their free borders approximate, touch, or overlap, and that the posterior opening of the chink is longer or shorter and different in appearance for each note. I wish to put on record here my opinion of the absolute impossibility of photographing the vocal chords during the proper emission of tone, from the very fact that the laryngoscopic mirror placed in the pharynx interferes with the right focus of the respiratory attack, and it is only possible to observe the vocal chords in the photograph when the so-called stroke of the glottis is used in the emission of a note. The photographs of singers' chords and the deductions which have been drawn from their appearance during the emission of different notes only demonstrate, in every case that I have ever seen, that the larynx is elevated by the pulling up of the thyreoid, the chords relaxed and the free borders more or less approximated.

If we ask a singer who is in the habit of using the so-called high chest method of costal respiration to take a note (the attack entirely taken from the chords and focused in the masque, bringing into play the harmonics lent by the sound waves passing behind the uvula and soft palate), introducing the smallest possible size of mirror, so that the color given to the note by Nature's resonance pipes, the antra and nasal cavities, will be as little as possible interfered with, we are surprised to find that on the emission of every note of the soprano medium register the chords appear equidistant from each other throughout the entire extent that it is possible to see them.

The part which the intrinsic muscles of the larynx play in the tension of the vocal chords becomes an interesting study. It is very easy for us to see by the depression of the thyreoid how the chords must be elongated, but it is extremely difficult for us to comprehend the minute differences of tension caused by the movements of the thyreo-arytænoid and crico-arytænoid muscles. I have frequently been surprised upon examination of the vocal chords with the head held down, the chin resting upon the chest, to find the chords present a beautiful pearly appearance, entirely homogeneous; but upon attempting to show the patient his own chords by an adjustment of double mirrors, the head being slightly thrown back, upon the same note the chords suddenly have become dusky, semi-congested and striated. How much of this is due to the slight elevation of the thyreoid cartilage and how much to the intrinsic muscles of the larynx, or to the relationship between the chink of the glottis and the trachea, it is difficult to determine. To a careful study of these differences of tension am I indebted for the discovery of a fact which I here write about for the first time, the appreciation of which fact, however, has entirely changed my treatment of the singing larynx, and has caused me to institute a system of tone exercises by which certain intrinsic muscles of the larynx are so strengthened that any medical application through the medium of sprays, probangs, and, I may say, instrumentation, has ofttimes been entirely done away with.

If we take a good sized laryngoscopic mirror—No. 4, for example—and ask a patient to sing "E" or "Ah," the chords come into view for two reasons: First, the epiglottis becomes more perpendicular, allowing a better view of the bands; and secondly, the chords themselves are on a more elevated plane, owing to a slight elevation of the thyreoid cartilage and consequent relaxation of the intrinsic tensors of the chords. In this position we remark that the free borders of the chords come together in the anterior and central portions, and we are able to study the initial tone attack, the membrane separating as the tone bursts through the closed chink. This picture may be said to be an imitation, on a small scale, of the so-called stroke of the glottis. In this method of producing a tone, the initial attack being upon the chords themselves, the central portions of the chords necessarily touch. The peculiar muscular equilibrium which is employed in this mode of attack invites a reflex elevation of the soft palate, cutting off the oral from the nasal cavities. As we look at this picture our minds revert to the singing teacher who commands her pupils to keep their palates up, sing in the back of their heads and strike the glottis. Could ever villainy be more compounded? Let us take the same patient and require him to sing the same note, but in an entirely different way. We will first

* Read before the First Pan-American Medical Congress, September, 1893.—*N. Y. Med. Jour.*

* *Revue de medecine*, 1889.

ask him to expand his upper chest, not necessarily by respiration, but by elevation of the superior ribs by a muscular effort, at the same time slightly drawing in the abdominal wall. We now introduce the smallest mirror and ask our patient to sing "A," pronounced as in law or maw. With this position of the larynx and muscular poise we observe two things: First, the epiglottis does not assume its most vertical aspect, not inclining as near the perpendicular, and the soft palate and uvula do not spring upward and backward to make the partition between the mouth and naso-pharynx. Different in every respect is the tone produced by the chords, which may be assumed to vibrate longitudinally, but never touching each other in the middle portion, even in making the initial attack. The chords appear narrower, tenser, lower anteriorly, equidistant from each other, more homogeneous and whiter in color.

These two pictures should be well considered, as they become the basis of criticism in distinguishing the correct and eliminating incorrect methods, on the one hand, in singers' voices, and of the greatest assistance to the laryngologist in correcting pathological conditions, the result of bad training. The proper appreciation of these opposite conditions and their effect on the quality of tone immediately calls our attention to the subject of respiration. Within the past three years the entire theory of musical education has changed in France, the explanation of this change being that there is at present a better appreciation of the influences bearing upon the production of tone and a better understanding of the physiology of the larynx, by reason of the advances made in laryngoscopy.

Modern teaching tends to cultivate tone harmonies and sympathy in the voice at the expense of brilliancy of execution. The same judgment should be exercised in the training of an individual who proposes to make singing his or her art as should be employed in advising the painter that his special *forte* lies in landscapes rich in color, in which he may give expression to his imaginative genius, rather than to the sterner *facsimile* of portraiture.

How many singers we hear whose technique and brilliant staccato in the Bell Song of Lakme calls forth our admiration and amazement, but who are absolutely unable to put any sympathy whatsoever into the simplest ballad! We should study color harmonies in music in the same way that they must be studied in painting. There is no rule for the palpitating sunlight effects and prismatic play of colors in the school of Claude Monet; it is certainly a subtile feeling which is given by an ingenious mingling of pure spectrum colors. In the human voice that added coloring of tone which appeals to the heart as well as to the ear of the listener must be brought about by the employment of those harmonics which are added to the original tone by intervibrations within the accessory cavities of the nasal passages. To sing *dans le masque*, as the French say, is to give this added richness to the initial tone; but to sing in this manner requires the soft palate and uvula to be lowered in the production of tone. Likewise to make the purest initial tone from the chords, we must get the utmost possible tension, which may only be arrived at when the thyreoid is depressed, for, in proportion as the thyreoid is elevated, the chords tend to assume the base of a right angle triangle instead of its hypotenuse. Several elements besides this enter into the question of greatest possible tension, one of the most important of which is that the trachea be drawn down to assume the position that it takes when the apices of the lungs are filled to their greatest extent with air.

One of the greatest singers the world has ever known told me that the reason that he adopted a fixed high chest was that he had found, after the removal of a papilloma from one of his chords, that the only way in which he could be at all sure of his voice while singing was by the maintenance of the so-called high chest respiration. This is easily explained by the fact that in this position, the upper ribs remaining fixed, the apices of the lungs always remain in contact with the thoracic wall, expanded to their fullest extent, the chords being kept in their state of greatest possible tension. In this position the breathing becomes entirely inferior costal and diaphragmatic. The position of the thorax, as indicated above, permits the lungs to expand to their fullest extent, thus adding a secondary resonance to the voice from below—a sort of complementary *timbre*, the fixed upper thorax allowing of the least possible change of color during tone production.

It is this combination of facial and thoracic tone fortification which gives the enormous carrying power to tones produced by this method. For a number of years before I made a special study and estimated the great significance of these factors in singing, I deluged the throats of singers with sedative and astringent sprays when their chords appeared congested and swollen, often presenting nodules in their center which I had never previously recognized as being due entirely to singing with an improperly poised larynx.

I may cite several cases to show you the difference, from a medical standpoint, in the treatment of the singer's throat, where I now substitute respiratory and tone exercise for the amelioration of conditions that I have always been taught were only to be cured by rest and the diligent use of drugs. The cases I cite are typical of a class of singers that I have treated with equally good results since I have made a particular study of the peculiar value of the proper tone production in the human voice.

CASE I.—The first day of January last I was consulted by Miss F., aged twenty-three years, who had had a contralto voice of large power which she had employed constantly for several years, and had finally, after a prolonged concert tour with a well-known orchestra, entirely broken down. Her chords were dark red, with a slight nodule in the middle of either band; she complained of great pain in producing her notes, and her medium register had no power in it whatsoever. She had been told by two of the best authorities on the throat that she must not sing a note for a year, and must have her chords painted with astringent solutions and tone up her general health. Upon testing her voice, I remarked an extremely breathy tone and clavicular respiration.

In accordance with the principles which I have attempted to demonstrate, I forbade her speaking a single word for a week, but placed her at once upon the so-called inferior costal respiration, maintaining a high chest, and giving her directions to take a medium "C," with the chin almost resting upon the clavicle, singing the word "ma" for five minutes of each hour of the day, the two first to be focused in the face with the mouth closed, and the attack to break upon the lips as much as possible on opening the mouth. At the end of seven days the chords, instead of presenting an elliptical appearance, were straight, and the nodule was so far rotated upward on either chord that it did not touch the nodule of the opposite side in the emission of tone. At the end of the week this young lady, who considered her voice hopelessly destroyed, having acquired a new method of respiration, sang in a concert. She has since sung regularly in church, in many oratorios during the winter, and is at present singing three times a week in grand opera, learning new *roles* continually, apparently perfectly restored. She tells me her voice is far more powerful than she had ever dreamed of.

CASE II.—Miss P. H. consulted me on March 2 in great distress. She was obliged to sing in a comic opera on that evening or close the theater. Examination showed inflamed and bulged chords, with great hoarseness in the speaking voice; middle register impossible, but the high notes obtained with great effort. I sent her at once to my assistant, who gave her exercises to maintain tension, and at the end of an hour's work with tension exercises and inferior costal breathing the cords responded and she sang with ease.

CASE III.—Miss H. B. consulted me in May, having lost her position as prima donna by reason of loss of voice. Had been constantly treated. Her chords showed the nodules of attrition, the result of the employment of the *coup de glotte* and faulty respiration. In this case a week's work caused the nodules to disappear. She adopted a proper laryngeal poise and again assumed the leading *role*.

Observation.—In this class of cases rest causes a relaxation of the chords and singing becomes impossible for some time, whereas constant work, with tension of the chords and non-approximation of the same, gives immediate relief.

CASE IV.—Fraulein K. consulted me in the spring. Her chords appeared swollen and the membrane was injured, but not hyperæmic. Had been obliged to cancel her engagements and return to New York for treatment. I recognized the familiar picture and sent her to my assistant, who cured her in a week without other treatment than the establishment of a proper laryngeal poise.

With many cases like these which I might cite, may I not be excused in my assumption in calling attention to what I consider the most important ground principle of the singer's art—namely, the proper employment of the muscles of respiration, the poise given the chords and the proper use of the intrinsic muscles of the larynx, not forgetting the bringing into play of the accessory cavities of the face, which lend so much color to the tone, removing entirely from the chords the deleterious effects of an improper initial attack?

To rehearse briefly the deductions which I have attempted to draw from my argument, I maintain that the best method of respiration is the inferior costal or diaphragmatic, faithfully maintaining the elevation of the upper ribs without raising the shoulders. Next in importance is the depression of the thyreoid cartilage, brought about through the agency of the crico-thyreoid muscles and the pulling down of the trachea, by increasing the capacity of the upper lobes of the lungs—anatomically speaking, a pose causing the thyreo-arytænoid muscles to produce tension instead of the crico-arytænoids. Be careful that the initial attack is removed entirely from the chords. Lower the uvula and soft palate, that the sound waves may obtain their intercurrent vibrations or harmonics by partly passing into the nasal cavities from behind. Let us not fall into the error that the roof of the mouth alone is the sounding board of the singing voice, for without that added richness and *timbre* to be given by calling into play nature's resonance pipes, the nose and its accessory cavities, we may sing, but the singing is at the expense of the chords, and the life of the voice is necessarily shortened.

If I have said enough to arouse a new interest in what I consider a most necessary accessory to laryngology, I shall feel amply repaid for my endeavors to set the theme before you in a clear and comprehensive manner.

BOVINE TUBERCULOSIS.

By HENRY G. WOLCOTT, New York State Commissioner of Health.

IN a recent letter to the editor of the *Orange County Farmer*, State Commissioner Wolcott gives the most recent information on the above subject, as follows:

I have read with much interest in your issue of March 8 the statements relative to bovine turberculosis, and the efforts of the State Board of Health to call popular attention to the same.

Since comparatively little is generally known upon the subject, I think it may not be devoid of interest to your readers to learn some of the facts which have induced such efforts, and while in thus addressing you I shall have, necessarily, to indulge in the "scientific," I believe that all information upon this most important subject is worthy of attention.

Bovine tuberculosis is practically the equivalent of the like disease in humans, be it known as pulmonary tuberculosis or consumption, as lupus, as tuberculous fistulas, as scrofuletic affections, or under many other names familiar to the medical profession, varying in name with the symptoms or part affected. In all such cases the cause of the disease is the "bacillis tuberculosis," a microscopic vegetable parasite, in shape like a bit of very fine thread, and when viewed through a microscope of say 1,300 diameters, appears to be about a sixteenth of an inch in length. These germs increase by segmentation, that is, they break up, and each thread-like piece is capable, under favoring circumstances, of lengthening, breaking, and in time producing others. They do not multiply except in living tissue or in animal products, such as blood, serum, beef broth, or the like; and while they may live for years outside the animal or its products and be capable of producing the disease, still sunlight will destroy them in the course of a few hours. Nature has thus put a limit to their destructibility, and has also given to healthy animal tissue, in the great majority of cases, the power of expelling or annihilating the germ, else tubercular affections would be far more prevalent than at present.

The importance of this germ theory of disease as applied to tuberculosis is thus clearly recognizable, and to Prof. Koch is due all credit, for the discovery is distinctively his. It is now classified by our best sanitarians as a "preventable disease," and in the same category as diphtheria, smallpox, scarlet fever, etc. The importance of this discovery is emphasized by the fact that about thirteen deaths out of every hundred are caused by some form of this disease.

Viewed solely from its sanitary standpoint, this discovery marks an era in the nineteenth century. That the cause of this disease and the disease itself exist in cattle, that cattle can communicate it to members of the human race and to other cattle, is without doubt. That it can be communicated from man to cattle is also acknowledged. That it may be, and in many cases is, hereditary, is also established; or, if not always hereditary, the offspring of tuberculous parents are more susceptible to its influence than are the offspring of non-tuberculous parents.

There are within the State of New York about a million and a half of milch cows, and about two and a half million of animals whose annual dairy product exceeds $35,000,000. The records of the State Board of Health show that 3½ per cent. of all cattle examined are tuberculous. Hence, looking at the question from a pecuniary point of view solely, how vast the interests affected. Considered from both the sanitary and pecuniary standpoints, how momentous a question this proves itself to be.

The cause of all this trouble, the bacilli tuberculosis of Koch, is readily isolated from other bacilli. A dilute solution of nitric acid has no effect upon them, while destroying other germs. Again, a dye known as "carbol fucine" will stain them a dull red, having little or no effect upon other bacilli. If, then, upon a microscopical examination, we find them in diseased tissue, inoculate healthy tissue with them, again finding the specific germ, and carry this operation on through seventy different series of animal cultures, taking proper antiseptic precautions in every case, and have the seventieth subject die from symptoms tuberculous in their nature, still finding the same specific bacilli, we may reasonably conclude that it is the cause, and not the result of the disease. This has been done by Prof. Koch and other observers, and the results as stated established and acknowledged as facts. The only animals, so far as known, upon which such inoculations have no effect are rats and mice. Guinea pigs and rabbits are particularly susceptible to its influence, and upon them the great majority of experiments have been made.

The contamination from the human to the human or to the bovine is presumably by the sputa, which, when dried, permits the bacilli to be carried by the air, and when a suitable lodgment is found in susceptible tissue, either in the respiratory or alimentary tracts, germination and increase may result, producing a tubercular affection, specifically named in accordance with the organs affected. The communication from the bovine to the adult bovine is by the sputa mainly, the well known habits of cows licking each other, feeding from the same troughs, etc., being familiar examples. Calves frequently take it in their mother's milk. It is mainly communicated from the bovine to the human through the milk.

While it may be communicated through tuberculous meat, the fact that meat is usually cooked and that a temperature of 160° Fah. is maintained will destroy the bacilli and prevent much danger on this score. A tuberculous cow may or may not have tuberculous milk, depending in measure upon the part affected, and the extent to which the disease has developed. When the mammillary or milk glands are so diseased, the milk is generally tuberculous. The certainty that a tuberculous cow having non-tuberculous milk at the time of observation will, during her life, limited at the best to a few months or years, prove a source of contagion to all remaining healthy members of the herd, the fact that her milk may at any time become tuberculous, and the further fact of her progeny being probably tuberculous, would warrant her destruction. A tuberculous bull is not a fit animal to breed from, no matter how phenomenal his record as a progenitor of milk-producing cows. It is a curious fact that butter when made by either the separator or ordinary methods seldom contains tubercular germs even when made from milk known to be tuberculous. The reason for this doubtless is that the specific bacilli referred to are heavier than the milk surrounding them, and fail to become entangled in the lighter or butter-producing portion. This fact enables the skilled pathologist to the more readily find the bacilli by using a centrifugal apparatus which concentrates them in a certain portion of the fluid under examination.

About two years ago the State Board of Health, recognizing the important bearing of the facts above mentioned, commenced its crusade of enlightenment. It takes to itself no little credit that among all the States of the Union it was the first to establish a department devoted solely to this work, where the latest and most authentic information upon the subject could be collected and collated, and where the correctness of theoretical deductions, based upon such facts, could be practically proved or disproved. Pennsylvania, Rhode Island, Massachusetts and sister States are now following in our lead, and the Bureau of Animal Industry in Washington, D. C., is exhaustively examining the question.

The use of Koch's tuberculine or lymph as a diagnostic agent in cases of suspected tuberculosis has vastly increased the possibilities of eradicating the disease. Many fallacious notions exist as to this tuberculine and its effects upon the animal inoculated. In the hands of a skilled, conscientious and experienced specialist, it can effect no possible injury. It will not cause the disease, nor will it increase the disease in affected animals. In unskillful hands it is likely to give results that are not borne out by the *post mortem* examinations. In the hands of a skilled, conscientious and experienced specialist the information it gives may almost be said to be infallible.

There are as yet certain attendant facts and circumstances connected with the correct readings of the indications it gives that make the information obtained by physical examinations important in doubtful cases,

and while the State Board of Health uses its best endeavors to obtain inspectors who shall fulfill all the requirements of the ideal inspector, still the limited annual appropriation of ten thousand dollars will not permit of its paying salaries to its inspectors commensurate with the skill and experience demanded. The faulty diagnosis, as evidenced by the *post mortem* examinations amounting thus far to about three per cent. of the animals slaughtered, is due not to errors in the principle employed, but to errors in the method, carelessness or ignorance on the part of the user of such principles, and in nowise affects the efficiency of the tuberculine test as a diagnostic agent.

The tuberculine is imported into this country, and although the department in Washington has the formula for its production, still the febrile reaction of the two brands differs. Just what or how the tuberculine is produced is not generally known. It is generally believed to be a ptomaine of the bacilli tuberculosis in pure glycerine.

We will suppose that the owner of a herd of say forty head has, during the past year, unaccountably lost two or three animals. Some of his cows have rough coats, feverish eyes, are thin and low spirited. The milk supply may be normal or even increased. Two or three have a cough, and to sum it up the owner would say his cows are "sick." He hears of consumption among cattle and writes to the State Board of Health at Albany, asking that an examination be made of his cattle at the expense of the State. After waiting several months (we have over fifty applications on file and unattended to), he receives notice that on a certain day the inspector will make an examination. He is asked how long since his cattle first became "sick." Inquiry as to cattle purchased at or before such first sickness will be made, and the chances are more than even that the purchased animal came from a herd known to be tuberculous. The cattle are then numbered, examined physically with much care, and the results entered.

If the facts warrant it, the cattle are thereupon tagged and quarantined. The owner is directed to remove all cows within two weeks of calving, and all cows bulling unless the physical examination clearly shows them to be tuberculous. The reason for this is that the tuberculine test is apt to give undue reactions in such cases and to similarly feed and water his entire remaining herd. One hour after feeding the temperatures of all animals are to be taken by thermometers, the similarity of whose readings under similar changes of temperature the inspector has previously established. He will take temperatures five hours thereafter and again at ten hours. During the interim the cattle are to be neither fed nor watered. Careful entries are to be made of all results so obtained.

He will then order the cattle well fed and watered and will proceed to inoculate the animals with tuberculine, using his judgment as to the amount to be injected, based upon the weight of the animal to be tested. About seven hours hereafter he will again commence taking temperatures and without permitting feeding or watering take eight temperatures at intervals of two hours each, after which the test ceases and the animals may be fed and watered.

Now commences the real work of the inspector and upon which his reputation and the reputation of the board depends. The inspector will remember that temperatures are nearly two degrees lower between twelve and two at night than at midday, that free watering may reduce the temperature one and a half degrees, that a bull has two degrees higher temperature than a cow, and that chewing the cud is certain to run the mercury up at least one degree.

It is trying work, and the tendency is to let the doubtful cases remain under quarantine pending subsequent examination. This, however, is a hardship upon the owner, and should be, so far as possible, discouraged.

Depending upon the results of his study of the chart, he orders some freed from quarantine; some he continues under quarantine, and for some he orders killing cards from the ward in Albany. If the rise is spasmodic, resuming or approximating the normal as the tests continue, other things equal, the animal is non-tuberculous. If there is a gradual and regular rise, reaching its maximum at the seventh or eighth test and showing an increase of upward of three degrees above the normal, the animal is almost certainly tuberculous and should be killed. When received the cattle are killed under his direction and *post mortem* examinations made. The carcass is buried usually in quicklime or removed to a phosphate factory.

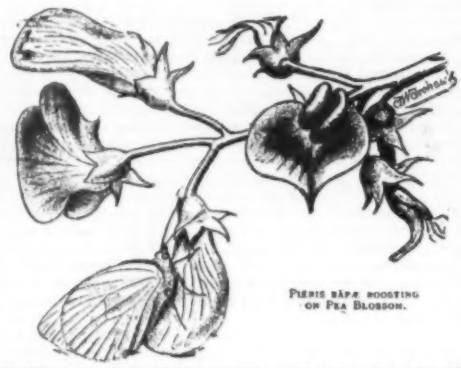
It is believed by the board that it as a body cannot alone ever eradicate this disease. The subject is too vast to seriously undertake. It wishes to bring the subject before the people, and let the individual or the local boards in co-operation with the State board attend to the details. It is hopeful that the health departments of cities will appreciate the importance of the subject and issue a quarantine against tuberculous milk. It hopes that in the near future a corps of specialists will be granted from our agricultural and veterinary colleges whose certificate of immunity will be a prerequisite to the possibility of sale, and that the ultimate result will be a material lessening of the death rate and a demand for the animals and dairy products from the State of New York by reason of their known freedom from disease.

ROOSTING BUTTERFLIES.

By JOHN T. CARRINGTON.

CONSIDERING that more than half the span of life allotted by nature to the perfect state of butterflies is spent in sleep, it is of the first consequence that the manner of roosting should be as far as possible protective. Alert and well able to save themselves during the active period of their existence, when the sun is hot and their power of flight is strong, they are perfectly helpless in the dusk of evening, the night time, early morning and on dull days. Then we may pick them up with our fingers and place them on our hands without the slightest show of movement on the part of the insects. When in this condition of torpor or sleep induced by absence of sunlight, butterflies form an easy prey to prowling enemies, which may by chance take them before they have provided for the continuance of their species. Therefore, we must conclude that the habit of roosting adopted by each kind is most conducive to protection during the long hours of sleep.

When we take the list of the European Rhopalocera and scan it deliberately through, it is only possible to come to one conclusion upon the knowledge possessed as to the manner of roosting of the various butterflies. Indeed, we, in this country, need not take the whole European list if we are in search of discovery into the resting habits of these insects. Very little is really known about the roosting positions, from the protective point of view, of the majority of our British species. Most entomologists know how to hunt for several of our "blues," or Lycænidæ. Various kinds are to be found so soon as



PIERIS RAPÆ ROOSTING ON PEA BLOSSOM.

PIERIS RAPÆ, ROOSTING ON PEA BLOSSOM.

the sun has set, resting upon the stems of grass; though not all the species affect the same position. Some species invariably rest with the head of the insect turned away from the earth, looking skyward, while other species always roost with the head looking downward. One wonders why nearly allied species, with the markings and ground color of the underside of the wings, which is the only side visible among this group when roosting, should invariably adopt these unlike positions on the stems of grass.

Some of the fritillaries (Argynnidæ) and *Melitæa* often affect the heads of flowers as the night resting place, though I fancy this is rather accidental than otherwise. It may be those frequenting the flowers at night were "caught" in that position by the sun going down while they were feeding off the honey in the flowers, as so often seen with humble bees. We cannot find a large proportion of say *Argynnis euphrosyne* or *Melitæa athalia* out of the total population of these species in any locality affected by them at rest on the flower heads. Still it is not uncommon to find both species in that position on a dull morning after a bright day. I have seen seventy of the latter kind on heads of thistle and other flowers in a single morning, in the great wood near Hailsham, in Sussex. So, likewise, may we find the grizzly skipper at rest, though chiefly on lower growing flower heads. *Hesperia comma* sits upon the smooth stems of young hazel boughs in woods, on the borders of the chalk downs where it flies, and *H. sylvanus* has much the same habit. Another of our skippers, *Nisoniades tages*, may be taken in sufficient abundance by searching the dead seed capsules of the plants of black knapweed of the previous year. This species roosts in a position quite unlike others of the group native to these islands. It folds its wings under the body, like a noctuid moth. On one evening, on the Horsley Sheep Lees in Surrey, I searched a dead plant of knapweed for varieties of this dingy skipper butterfly and took sixteen specimens off about ten seed heads. Being unable to find more, I shook the plant into my entomological net, with the result that four additional butterflies were shaken off. The protective position selected was so perfect that all my trained experience failed to show me the remaining four on the plant.

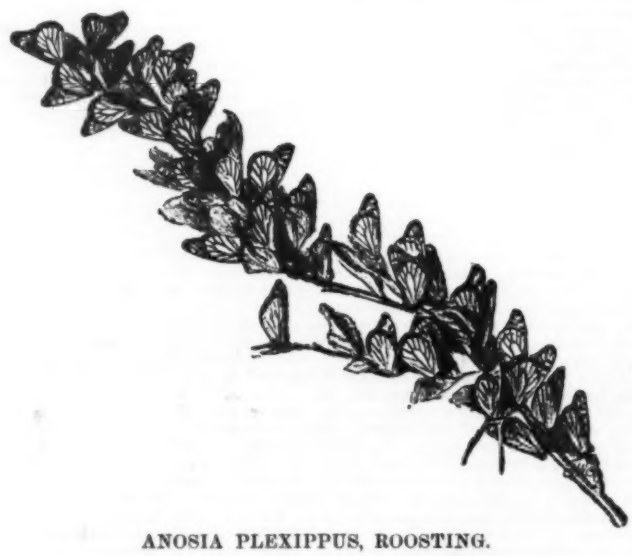
I quote Mr. F. W. Frohawk's notes, taken when he sketched the white butterfly sleeping on a pea flower, herein reproduced from his drawing.

"August 19, 1885, between 10 and 11 A. M., dull day, found *Pieris rapæ*, female, at rest on pea blossom, which it closely resembles and mimics both in form and color. It remained motionless until noon on the following day, when the sun shone for a short time, and it flew away. The similarity between the unexpanded blossoms and the resting butterfly was an excellent example of protective resemblance."

About three years ago I was visiting a house well covered with ivy of a variety with rather large leaves. One recently grown branch had developed a few whitish or cream colored leaves, as a "sport" among the ordinary green leaves. This branch being near the dining room window, was convenient for observation. Every evening for several days, about sunset, a large cabbage white butterfly (*Pieris brassicæ*) used to search out one of these half dozen white ivy leaves, and roost upon it for the night. The protective value of the creamy white leaf for the creamy white underside of the butterfly was perfect. The butterfly seemed to be the same individual on each evening.

The drawing of some three dozen Plexippus butterflies at rest on a dead branch of a shrub is taken from a photograph by Prof. C. F. Nachtrieb, of the Department of Animal Biology, in the United States of America, who lent the picture to *Insect Life*, the excellent journal published by the entomological division of the United States Department of Agriculture, in January, 1893 (vol. v., p. 206). This butterfly is larger than any species native to our islands, so an idea may be gathered of the appearance of the branch as seen by Prof. Nachtrieb. Being in color yellowish orgnge, with black veins, these roosting butterflies would have the appearance, when seen at a distance, of withered leaves attached to a dead branch.

Without becoming speculative as to how far the power of reason, as apart from instinct, guides, we cannot fail to see how important for the preservation of butterflies is the selection of suitable roosting places during the helpless period of sleeping. — *Science Gossip.*



ANOSIA PLEXIPPUS, ROOSTING.

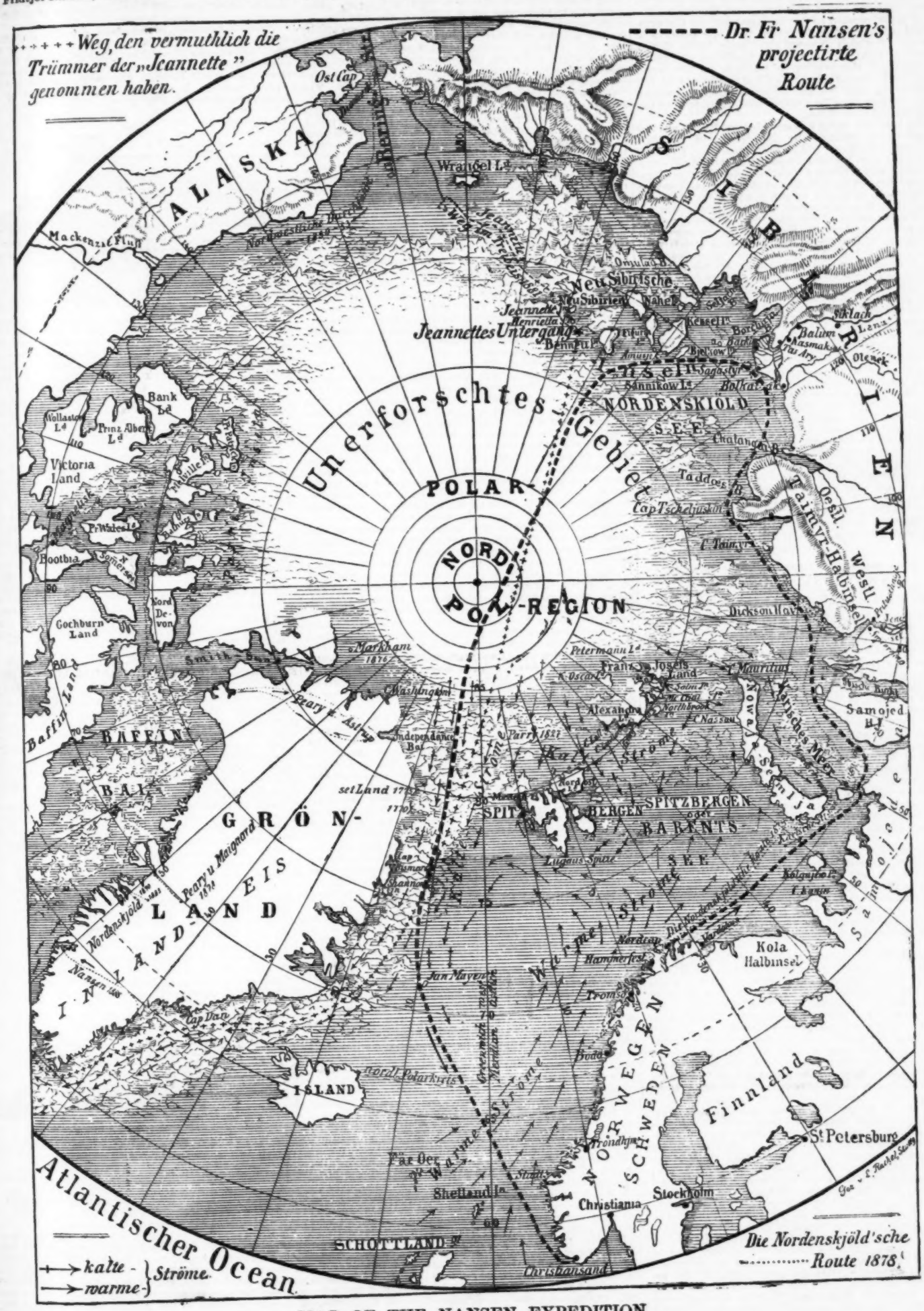
NANSEN'S EXPEDITION TO THE NORTH POLE.

THE remarkably brisk rivalry that has lately developed in the field of polar exploration gives ground for the hope that during the next few years many Arctic discoveries may be made which will be of great importance to science, so that in the near future the map of the North Polar regions will present quite a different picture from that with which we are familiar. The methods employed for conducting such expeditions, to say nothing of the latest scientific discoveries—such as electric light and the phonograph—that lend their aid, have opened a new era in polar explorations. The most notable ones, as far as the expeditions themselves are concerned, which will try to reach the North Pole from many different directions, are the following: The Norwegian expedition of Dr. Fridtjof Nansen, who hopes to reach his goal from the island of New Siberia; the North American expedition of Lieut. Peary, who will push to the north by way of Greenland; and the expedition of the Englishman, Fred. Jackson, who will take Franz Josephsland as the starting point. Besides these, an expedition consisting of eight persons will be sent out from America, for the purpose of exploring unknown Arctic regions. This party, which will be conducted by a German connected with the geological survey of the United States, Robert Stein by name, will go north along the western coast of Grinnell Land, because those who are supposed to know about such matters claim that the best route to the extreme north is along a stretch of western coast which extends to the pole. In connection with polar explorers we may mention the Norwegian, Martin Eckroll, a wealthy merchant of Lofoton, who is greatly interested in Arctic expeditions, and has a theory that a so-called sledge boat, drawn by a number of dogs, could go over the ice from Spitzenbergen to Franz Josephsland, and from there over the North Pole to the eastern coast of Greenland.

The polar expeditions mentioned, with the exception of the first two, will start next year. The Peary expedition, consisting of ten persons, started last summer, in the sealing boat Falcon, for Whale Sound, in the northern part of the western coast of Greenland, where the expedition will winter. In the spring the expedition will start by the route followed by the former Peary expedition over the inland ice to Independence Bay—shown in the accompanying map—and when this point is reached, they will divide into groups, one of which will be led northward by Lieut. Peary, while another will explore the unknown coast from In-

dependence Bay to Cape Bismarck, a stretch of about 300 English miles. At certain places on this coast line land has already been seen from the ocean.

But no expedition has caused so much discussion, or met with so much opposition, as that of the Norwegian, Fridtjof Nansen, who started from Norway in his vessel, the Fram, and went along the northern coast of Siberia, following Nordenskjold's route, and steering toward New Siberia Islands. He expected to turn north from this group of islands and push as far forward in the ice as possible, and then leave the rest to those currents in the existence of which he firmly believes, having based his entire plan on them. The point to which Nansen will push forward lies near the place where the Jeannette sank. Some articles left on the ice by the sailors were found, after many years, on the southwestern coast of Greenland, a circumstance that plays an important part in Nansen's theory that there is an oceanic current leading over the North Pole. This theory, and his idea of allowing himself to be carried over the North Pole by the ice, have caused much head shaking and sharp criticism in expert circles. The well known American Arctic explorer, Gen. A. W. Greely, speaks of it with especial severity, saying that it is impracticable, unwise, and almost equivalent to committing suicide to try to carry out Nansen's plan of drifting with the ice pack. A similar opinion has been expressed in English circles. But the existence of the currents counted on by Nansen has not been absolutely proved, and therefore, it is useless to discuss the practicability or impracticability of the plan. Nansen is a man to whom danger is of no importance as long as there is a chance of carrying out his project. He has doubtless understood the great risk that he runs, and it must be said in his favor that he has done all in his power to secure the safety of those who accompany him. Not the least important of the steps taken with this object in view is the peculiar construction of the vessel, especial attention being given to the fact that she would have a hard fight with polar ice, and an attempt being made to solve the problem of providing a vessel capable of



MAP OF THE NANSEN EXPEDITION.

resisting the crushing action of the mass of ice in the polar sea. The solution of this problem will be of the greatest importance to future expeditions, and on it, in connection with the special conditions, depends the success of Nansen's undertaking, which is of a purely scientific nature. However, the importance of the result cannot be calculated until after the material has been collected and worked up, and, therefore, the question must remain in the background for the present; but it must not be forgotten that the sciences in the service of which Nansen has gone touch closely on practical life. Of course, the expedition will make very important discoveries in relation to the ocean currents, and a knowledge of all the conditions of the currents in the seas toward which Nansen is turning his helm is necessary for a better understanding of the laws connected with them.

For the rest, the tasks before this expedition are the same as those planned by Nordenskjold in 1877. Among these geology holds first place, for, from all appearances, the Nansen expedition will strike new lands which will probably yield rich fields for geological exploration. The different explorers have theories as to what is to be found at the North Pole, and they prophesy that Nansen's vessel will be held there for years. The expedition will also find a fine opportunity for meteorological investigation, the icy sea north of Siberia and the islands therein offering a rich field for that study. For the sake of the meteorology of Europe it is, as Nordenskjold showed, of the greatest importance to have reliable information in regard to the divisions of land, and the conditions of ice, air pressure and temperature in each of those parts of our earth about which so little is known. This is such an extensive field that the scientific men on the Fram can be occupied with it for years. As the vessel will pass through parts of the ocean that are rich in animal life, there will be an excellent opportunity for much interesting work in this branch of study, as well as for the study of botany on new lands that may be discovered. There is very little chance of finding human beings in any of these undiscovered countries.

At any rate, the expedition of Dr. Nansen, which is unusually well equipped for scientific work, will have rare opportunities for making a success of the undertaking, even if Nansen should not be able to make exactly the voyage planned and laid out on the charts. Provided with provisions for five years, and a stronger vessel than has ever before started for the Arctic regions, this party of explorers can look forward confidently to accomplishing great things. The dangers of the Polar Sea have scarcely any terrors for Nansen and the men with him.—*Ueber Land und Meer.*

[FROM THE NATIONAL GEOGRAPHIC MAGAZINE.]

SHAWANGUNK MOUNTAIN.*

By N. H. DARTON, United States Geological Survey.

SHAWUNGUNK† mountain is a prominent range lying between Hudson river and the southern Catskills, in Ulster county, New York. To the eastward it rises from the Wallkill valley in steep inclines, surmounted by a high escarpment; to the westward it slopes to the Rondout valley. Along its axis it rises gradually south of Rosendale, and finally attains an elevation of 2,200 feet and a width of five miles. It continues to the southward, with somewhat decreased height and width, through New Jersey and Pennsylvania, where it is known as Kittatinny mountain, and gives rise to the Delaware, Lehigh and Susquehanna water gaps.

The well known summer resorts of Lake Mohonk and Lake Minnewaska are on the summit of Shawangunk mountain, in Ulster county, so that the region has become familiar to a large number of visitors. Unfortunately, however, no description of its geology has ever been published, and the meager references in the report of Mather‡ throw but little light on the subject.

During the autumns of the past two years I have had occasion to spend a few days on the mountain to determine the salient features of its geology in Ulster county, and they were found to be of great interest. In this article there is presented a brief summary of the results of my observations, but in a report on the geology of Ulster county, now in preparation, there will be a somewhat more detailed description of the region.

The structure of Shawangunk mountain, in Ulster county, is a particularly interesting illustration of close relation of rock texture to topography, for the presence of the mountain and its form are directly dependent on the structure of a relatively thin sheet of hard rock. In the accompanying illustrations an attempt has been made to represent its physiographic character, and the structure is shown in the cross section at the ends of blocks into which the supposed model is divided. The mountain consists of a widely extended sheet of Shawangunk grit lying on soft Hudson shales. This sheet lies in a gently westward dipping monocline, which is corrugated by a series of gentle longitudinal flexures. To the westward it dips beneath shales and limestones of the succeeding formations in the Rondout valley; to the eastward it terminates in long lines of high precipices which surmount steep slopes of Hudson shales. Its anticlinals give rise to high ridges and wide plateaus; its synclinals constitute in greater part the intervening depressions. In several portions of the mountain the grit has been eroded off the crests of the anticlinals and the underlying slates are bared. This is the case in a wide area southeast of Ellenville, in a long strip extending from near Lake Mohonk nearly to Rosendale, in a small area east of Wawarsing, and in the top of the mountain north of Lake Minnewaska. Mather has suggested that the great cliffs of the region are due to faults, but I find this is not the case. Only one fault was found, and this was a small overthrust in the Rosendale region. There are many slight faults of a few inches or feet, but they appear to be entirely in the grit.

The surface of Shawangunk mountain is nearly everywhere very rugged, and cliffs and rocky slopes abound. These consist of snow-white grits, more or less mantled with dark lichens, and are remarkably picturesque. There are many cataracts, several beautiful rock-bound lakes and widely extended views of the Catskills to the westward and the Hudson valley to the eastward. The ruggedness is due to the exceptional hardness of the grits, the softness of the underlying shales and a tendency to vertical jointing which gives rise to cliffs and clefts. There are low lines of cliffs all over the surface of the mountain, especially to the southward, but along the eastern face, where the grit is being continually undermined by erosion of the slate, they are of great prominence, in some cases having a nearly vertical height of two hundred feet and extending continuously for many miles. The "points" are projections or promontories of the eastern edge of the grit beyond the general crest line, due to a less degree of recession. Buntico point, Paltz point, Gertrude nose and Sams point are the most prominent of these, but there are many others of minor importance. The cliffs on the surface of the ranges are of various heights and lengths and rise along joint cracks. They face in various directions, but a north and south trend is predominant. They are usually in irregular, discontinuous steps on the slopes and face each other and inclose depressions of various sizes on the plateaus.

The lakes for which the mountain is famous lie in basins of moderate depth and are all near the top of the range. They are nearly surrounded by cliffs of Shawangunk grit of greater or less height, which add greatly to their beauty. The grit is mainly a massive white or gray quartzite or conglomerate, averaging 250 to 300 feet thick. The proportion of pebbles is large but variable, many beds being fine. The pebbles and grains are quartz and the matrix is siliceous. The conglomerate is the famous Esopus millstone, and has been largely quarried for two centuries.

The relations of the Shawangunk grit to the Hudson shale in the Shawangunk mountain region is one of slight but persistent unconformity. The coarse grit lies directly on the eroded surface of the shales. This erosion has truncated low arches of the slate, but has channeled its surface only slightly. Exposures of the relations are everywhere abundant. One of the best instances is along the road from Minnewaska to New Paltz, two miles south of Lake Mohonk. Here along the mountain slope a very low arch of the grit is seen surmounting a truncated arch of shales of materially steeper dip. Diversity of dip is seen at every locality, varying from very slight to 10°, but several points were observed where it was hardly perceptible.

The corrugations in the general monocline of the mountain are a series of anticlinals and synclinals which traverse the range diagonally from north-northeast to south-southwest, and begin in succession from northeast to southwest, their axes rising gradually to the southward. Beginning at the northern end of the range, the principal feature is the anticlinal which brings up the cement between Rosendale and Whiteport. South of Rondout creek, opposite Rosendale, the upward pitch of this flexure increases rapidly, and the Shawangunk grit soon rises into a ridge of considerable altitude. In a short distance from the creek the grits are eroded from the crown of the arch, and to the southward the underlying shales constitute a series of high but rounded hills extending along the center of the mountain.

The occurrence of these high hills of soft rock is a striking feature, and they give a unique character to this portion of the mountain. Their presence is due to the former protection of the arch of Shawangunk grit by which they were originally covered. The grit in the flanks of this arch extends down the slopes of the mountain, where it dips beneath overlying formations in the valley on the western side and extends nearly or quite to the base on the eastern side. One mile and a half south of Rosendale the range has the structure shown in the first section of the illustration. It will be seen that the sheet of grit lying along the eastern slope of the mountain is considerably corrugated. This corrugation consists in the main of a western limb dipping more or less steeply eastward and a shallow synclinal. In one portion of the ridge there is a very abrupt anticlinal crumple in this synclinal which extends but a short distance in either direction and then flattens out into the general flexure. There is also a fault which extends from the Rosendale cement region. It gives rise to a sharp ridge which continues to the first road across the mountain, beyond which it dies out. Along the eastern face of the northeastern range of the mountain the dips are in greater part gently to the westward. Along the railroad they are 20°, and this is the average for some distance. On the first road across the mountain the dips are 60°, but this steep dip soon gives place to inclinations of not over 10°, and toward the southern end of the ridge the synclinal dies out, leaving a gentle dip eastward. This grit area lying along the eastern slope of the mountain terminates abruptly southward in a fine line of cliffs, which, owing to the upward pitch of the bed in this direction, are of great elevation. This is Buntico point, one of the most prominent topographic features in the region.

South of Buntico point the eastern crest and summit of Shawangunk mountain consists of a great mass of Hudson shales, which are being rapidly and deeply eroded. They extend southward nearly to Lake Mohonk, where the crest of the anticlinal is occupied by grit for some distance. The grit in the western limb of the anticlinal on the northern end of the mountain lies part way down the western slope and does not attain the prominence that it has in the area terminating in Buntico point. It constitutes a monoclinal ridge, with a line of cliffs along its eastern edge, above which the hills of Hudson shales rise several hundred feet. To the westward the Shawangunk grit dips beneath overlying formations in the synclinal valley of Coxingkill. On the opposite side of this valley, at High falls, there rises one of the principal anticlinals of Shawangunk mountain, which soon brings up Shawangunk grit in the low ridge on which the village is built. This ridge gradually increases in width and altitude southward, and near the line of the third section on the illustration its crest is nearly as high as the ridge eastward, from which it is separated by the synclinal valley of the Coxingkill.

South of Alligerville the mountain widens rapidly as flexure after flexure brings up the Shawangunk grit from the northwestward. The western ridge rises gradually on the upward pitch of the axis of the flexure and finally becomes the highest part of the mountain east of Ellenville. Southwest of Lake Mohonk there are five of these flexures, together with various small undulations, with a creek in each synclinal. Lake Minnewaska is in the crown of the anticlinal which rises at High falls, and Lake Awosting is on the western slope of the same flexure.

These lakes are all situatedn ear the eastern side of the mountain and about 150 feet below the crest. They are similar in relation and originated under almost the same conditions. Lake Mohonk occupies a north-and-south cleft in the crown of the anticlinal which rises at Rosendale. The structure of Lake Mohonk is shown in Fig. 1.

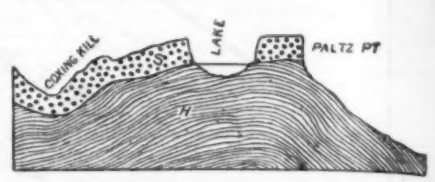


FIG. 1.—Cross Section of eastern Ridges of Shawangunk Mountain through Lake Mohonk, looking northward (S, Shawangunk grit; H, Hudson shale). Vertical scale exaggerated.

The lake basin is in Hudson shales, but it is bordered on the east and west by high cliffs of Shawangunk grit. To the south there is a gap in the front of the mountain through which the shales extend to the lake. The top of these shales is a few feet above the surface of the lake at its southeastern end, but the pitch carries them a few feet below the water surface toward the north and west.

This view is looking to the southward and out of the gap in the eastern front of the mountain through which the Hudson shales extend to the lake. On the left is Paltz point, and to the right, in the distance, is Cope point, a projection of the southern extension of the eastern front of the mountain.

East of the lake there is a thick mass of grit, which lies along the crest of the anticlinal. It begins a short distance northward and is terminated by very abrupt cliffs in Paltz point, near the southern end of the lake.

At the head of the lake and the base of the southern end of the mass of grit in Paltz point the Hudson shales constitute a small plateau which surmounts the long eastern slope of the mountain. There is no cross drainage way at the base of the cliffs, and the reason for the abrupt termination of this point is obscure.

The grit dips gently west-northwestward along the western side of Paltz point and very slightly eastward in its easternmost part. Northeast of the lake the dip is at a low angle to the westward, but there are several slight undulations. There is everywhere a pronounced pitch northwestward. Owing to the westerly dip the grits in the Paltz point ridge are somewhat lower just north of the lake than elsewhere. It will be seen from these statements that the lake lies slightly west of the center of the arch of the anticlinal, and all the dips along its shores are northwestward, although at very low angles. The degree of dip rapidly increases down the western slope of the mountain into the synclinal valley of Coxingkill.

The outlet of Lake Mohonk is to the northward by a branch of Coxingkill. This branch flows through a slight depression separating the Paltz point range from the main mountain mass, and then obliquely down the flank of the anticlinal.

South of Paltz point the eastern front of the mountain presents a nearly unbroken line of high cliffs for many miles along or near the crest of the anticline.

Two miles south of Lake Mohonk there is a slight depression in the crest line through which the road to Lake Minnewaska passes, and there are several other depressions of less amount. Millbrook mountain is the culminating feature of this portion of the range, beyond which its front is somewhat more irregular in contour.

Lake Minnewaska is similar to Lake Mohonk in appearance, but it is somewhat larger. It was not ascertained whether its basin extends into the Hudson shales, for there is a continuous rim of grit surrounding it. As a very great thickness of grit is exposed above the water level in this vicinity, it seems probable that the bottom of the lake is in or very near the shales. This probability is increased somewhat by the presence of

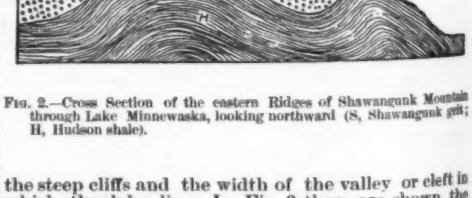


FIG. 2.—Cross Section of the eastern Ridges of Shawangunk Mountain through Lake Minnewaska, looking northward (S, Shawangunk grit; H, Hudson shale).

the steep cliffs and the width of the valley or cleft in which the lake lies. In Fig. 2 there are shown the principal structural features at this locality.

The cliffs which extend along the eastern side of the lake are very high and precipitous. As at Lake Mohonk the rocks are greatly fissured and are traversed by many deep, wide clefts. The dips are gently anticlinal about the lake, which is on the axis of the flexure, but they increase in amount to the east and west. The lake empties to the southward through a wide gap into the synclinal valley of the Coxingkill, and it may be regarded as the head waters of this stream.

A mile northeast of the lake the anticlinal on which the lake is situated is crossed by the road to Port Hixon, and in the vicinity of the road the grit has been removed from the crown of the arch for some distance. The road crosses the ridge in a gap on the Hudson shales, and the edges of the grit give rise to high cliffs on either side. Down the slope aways the grit outcrops on the flank of the arch, but the slate extends along the upper slopes of the mountain for some dis-

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* Published by permission of Prof. James Hall, State Geologist, in advance of the Annual Report of the Geological Survey of New York.

† Pronounced "Shongum," according to the residents of the region.

‡ Geology of New York: Report on the First Geological District, 1842.

tance, especially on the east side. The occurrence of the slate in this inlying area is a very striking feature, and the reason for the removal of the grit at this locality is not clear.

South of Lake Minnewaska the front of the ridge trends southwestward some distance and the Coxingkill anticlinal and the anticlinal next west pass out to the south. There is a prominent "point" in this vicinity known as Gertrude nose, which is due to a deep incision in the front of the mountain made by a small branch of the Wallkill. This stream heads on the plateau south of the lake, passes over the edge of the grit in a series of falls, and has cut a deep gorge into the Hudson shales below.

Lake Awosting is the largest lake of the series, and has a length of about a mile. It is surrounded in greater part by low cliffs and rocky slopes, but near its eastern end there is a line of very high cliffs which extends in from the crest of the mountain eastward and constitutes a high, west sloping plateau northeast of

FIG. 3.—Lake Awosting from the East-northeast, Sams Point in the Distance.

the lake. In Fig. 3 there is given a view of this lake based on kodak photographs.

The basin of the lake does not appear to be in Hudson shales, although possibly they underlie its deeper portions. The grit dips gently westward along the lake, and this dip continues over a wide area of surrounding region. On the west there is a long slope to the main Peterkill valley, which extends from a low cliff along the lake. The outlet of the lake is by a fork of the Peterkill, which flows along the west sloping grits for half a mile, and then in high falls over the grit into the kill. East of the confluence there is a narrow depression known as Dark hole, which extends southeastward up the slope of the mountain. It is rimmed by moderately high cliffs of west dipping grit and was cut by a stream which empties into the Peterkill. On the southern side of Dark hole is the high plateau of which the eastern front constitutes the cliffs at the southeastern end of Lake Awosting.

The Peterkill valley from beginning to end extends along the western flank of the anticlinal on which Lake Minnewaska is situated, and has a cliff of west dipping grit on its western side and slopes of grit on its eastern side. Four miles below Lake Awosting the kill passes over Awosting falls and then over a series of cascades, aggregating in all a fall of over 240 feet approximately. In Awosting falls there is a clear fall of 60 odd feet. They are a mile north of Lake Minnewaska. In the gorge below the several falls there are high cliffs of grit for some distance, but owing to considerable pitch northward or down stream and a thickness of grit somewhat over 200 feet, the kill has not cut through to the Hudson shales.

South of Lake Awosting there are two small, shallow ponds on the summit of the mountain. Mud pond, at the head of Fly brook, the principal fork of the Peterkill, is one, and Lake Maratanza is the other. Lake Maratanza empties eastward by a branch of the Wallkill, which pitches over the edge of the grit on the crest of the mountain, in a great fall into a deep gulf of Hudson shales. The locality is known as Verkeerder falls.

Between Gertrude nose and Sams point the crest of the mountain is very high, but for some distance the edge of the grit is broken into great terraces, and there is a sloping bench of Hudson shales of some width at the base. Several branches of Wallkill drainage head in the crest of the mountain in this region and pass over the edge of the grit in falls of which the above mentioned Verkeerder falls are the most noteworthy.

In this region the mountain narrows and some of the flexures pass out to the southward. This narrowing is due to recession of the edge of the sheet of the Shawangunk grit, which is closely related to the upward pitch of the flexures. This pitch increases the height of the mountain southward, but with increased height there is a corresponding increase of erosion in the soft underlying shales, which, beyond certain limits, causes rapid recession. This is illustrated by Sams point, where the maximum altitude of 2,240 feet is attained. The "point" is a narrowing extension of the grit along the axis of a very flat synclinal, which finally terminates in a high narrow cliff presented southward. From the wide anticlinal area to the west the grit has been eroded, and the Hudson shales occupy the surface in a group of very high hills. These hills are surrounded by cliffs of the grit, which on the eastern side, rise somewhat above their summits, on the northern are about even with their higher summits, and on the western lie along their flanks. Originally the grit area in this region and southward was as wide as it is now at Lake Mohonk, but, owing to the greater height to which the northern pitch of the flexures carried the grit, it was here more rapidly and widely undermined and removed. It is the grit on the western limb of the anticlinal that lies on the western flanks of the shale hills, constituting a monoclinal ridge of considerable prominence, which extends from Ellenville far southward into Pennsylvania. This monoclinal mountain consists of a single-crested ridge of the Shawangunk grit, with a long slope up the dip from the valley westward, which terminates in an east-facing cliff of grit surmounting long rolling slopes of shale on the eastern side of the mountain.

Its structure near the southern edge of Ulster county is shown in the illustrations, and this is typical for the greater part of its course. In the valley westward there is a succession of formations overlying the grit. They are the Clinton red shales, Salina water lime, Helderberg limestone, Oriskany sandstone, Esopus shales, Onondaga limestones and a great mass of Devonian shales and sandstones which extend into the Catskills. The dips along the western slope of the mountain are low north of Wawarsing, but they rapidly increase southward to an average of about 60° in the vicinity of Ellenville. In this region of steep dips the streams flowing down the steep western slope have cut deep gorges, which extend through the grit into the underlying shales. The two streams south of Ellenville are exaggerated examples of this, and they have been largely instrumental in baring the Hudson shales on the anticlinal area behind Sams point. The two streams just north of Ellenville also cut into the shales, but they are very small and have only formed narrow gorges. Opposite Napanoch is a small creek which has cut a deep gorge into the shales, and in the higher part of the slope has bared the grit from an area of considerable size, which is surrounded by high cliffs. The stream opposite Wawarsing has cut a gorge and removed an area of the grit on the upper slopes of the mountain, but does not cut through to the shale. The head of this depression extends into the head of the depression opposite Napanoch, and both are surmounted on the east by a continuous line of high cliffs. The stream which flows out of the mountain at Port Hixon is larger than the others and has cut a deep, wide gorge; but owing to the lower dip of the grit, it does not appear to have cut through to the shales to any great extent. No shales were observed in place in the depression, but a small amount of shale debris was noticed at one point. Everywhere along the steep slopes there are clefts in the grit, some of which appear to extend down to the shales. One of these is the "Ice cave," a locality which is widely famous in the region. It is high in the slope, about two miles east-northeast of Ellenville. Ice and snow remain in it in greater or less amount, and in some seasons they are preserved entirely through the summer and autumn. In the vicinity there is also an old copper mine from which large supplies of fine quartz crystals were obtained some years ago. The top of the mountain southwest of Wawarsing is a wide plateau, which is traversed by the valley of Stony creek. Its surface is very irregular and low cliffs of the bare grit abound.

The grit in the higher portion of Shawangunk mountain nearly everywhere presents a basined surface. These basins are depressed an inch or two below the general level and are of various sizes and shapes. They usually contain pools of water and some sand and pebble detritus. They are mostly smooth and even polished and are distributed all over the mountain, but particularly on the western slope. With the polishing are associated lines of glacial scorings and striation, which are conspicuous at nearly every locality. Julien* has recorded the direction of some of these striæ and scorings. The general direction is southwestward and the average depth is between one-sixteenth and one-eighth of an inch. In the vicinity of Sams point the most abundant scratches trend south 46° west and south 29° west. A few were observed somewhat more to the westward in direction, one-fourth inch in depth.

In the vicinity of Lake Mohonk, about the hotel and on the northwestern slope, south 10° west is the general direction; on the southeastern side of the mountain and on the road to Alligerville, it is south 40° east, and at Sky top, south 18° east. At Lake Minnewaska the trend is south 10° west. There is but little foreign glacial drift on the summit of the range, so far as observed, but there is considerable in the adjoining valleys.

The origin and history of the lakes are not entirely clear, but they appear to be due to glacial agencies. The principal feature has been a local deepening and widening of a pre-existent valley, aided, at least in the case of Lake Mohonk, by the presence of shales at the point now occupied by the lake. They do not appear to be due in great measure to damming by glacial or other debris or to dislocation.

Owing to its prominence the mountain has been long exposed to erosion. Originally the grit was overlain by a great mass of limestones and shales and the rocks of the Catskills, but these were removed far down into the Rondout valley at an early period. During the glacial epoch there was great erosion and the removal of great masses of the grit, which is now found in drift far to the southward. To the glaciation, too, probably is due the abruptness of Paltz point and other features of that sort. The grit also originally extended far to the eastward, but, owing to long continued undermining by the removal of the soft, underlying shales, its front has receded to its present position. This recession is still actively in progress, and every year there fall great masses from the front of the mountain. One of the regions of weakness is Paltz point, for its base is exposed to erosion on several sides, and it will eventually disappear. Probably before it is gone the streams heading near its southern end will cut back through the shales at the head of Lake Mohonk, and this beautiful body of water will be tapped. Of course, this is all very remote, so far as human history goes, and artificial means will stay its progress in some measure, but it will all be accomplished in the near future, geologically speaking. Lakes Minnewaska and Awosting lie so far back from the front of the mountain that they will survive Lake Mohonk by a very long time.

* New York Academy of Sciences, Trans., vol. iii., pp. 22-29.

HINTS ON THE ART OF LANDSCAPE GARDENING.†

By THOMAS HAWKES, Member of Illinois Chapter, American Institute of Architects.

† Abstract from an interesting pamphlet on the subject. Published by J. C. Winship & Co., Chicago, 1894.

LANDSCAPE gardening is an art, and he who in its practice accomplishes the best results is the one who keeps closest to nature, develops all its possibilities and applies his art to nature in such a way that the art is not manifest. All designs should conform to the laws of nature. If they do not they never can be truly artistic. The work of the landscape gardener must necessarily include so much accurate knowledge of architecture, engineering and gardening of itself, that no mere novice can possibly attempt it with any beneficial results. The marvelous work of transforming the dreary sand dunes of Jackson Park into the wondrously beautiful World's Fair grounds was indicative of this, and the possibilities of aiding nature, by an art so complete as to be hardly visible, were illustrated then, in a way that was a liberal education to many millions of people and advanced the general ideas regarding landscape gardening in a way not possible by scores of years of teachers, books, or instruction.

The planting of our parks and gardens should have a great amount of consideration, and we should have a diversified vegetation, with an admixture of deciduous and evergreen trees, varied, too, from the native trees with regard to their suitability to the climate, so avoiding formality. The grounds can be improved from year to year with such permanent planting as can be afforded, instead of making a uniform mediocre effect.

Trees should be planted for a definite purpose; they are too often put in without due consideration, and sometimes with the effect *of hiding* desirable views. This illustrates the purpose they can fill of hiding objectionable ones, and sometimes by natural mounding and then planting, they effect this purpose better than high walls or fences. Trees planted in groups are effective in extensive grounds and give "distance." Those who have seen grounds where evergreens have been planted out at equal spaces over a large area of park-like land have doubtless been reminded of the childish use they made of the trees contained in their Noah arks. As a rule the custom prevails of planting trees too closely together; that, indeed, is *literally* imitating nature, for in many of our forests the trees crowd each other so closely that in the struggle for existence they starve, make only a puny growth, and ultimately die from a lack of a proper amount of light, air, and root nourishment. In trimming out forest trees, it has been my experience that it is as well to proceed cautiously at first, and remove only those which are injuring the growth of others, leaving the ones which promise a vigorous life. I have had the satisfaction of seeing the remaining trees make fresh wood, and grow with redoubled vigor. On a poor soil, with a dense growth of trees, it is unwise to give too much light and air at first.

As large masses of trees prevent the free circulation of air, it is as well in improving forest land to open some vistas, and give *lungs* to the woods, before thinning out too much. In doing this an opportunity is afforded to create park-like effects.

It is an objectionable practice to clip trees and top them; it certainly spoils their beauty, and in some cases the mutilation causes decay. If it is an objection to have trees with stately heads, because they take up too much light and space, do not plant that kind.

The general custom of selecting trees of a large growth for transplanting, so as to get an immediate effect, is characteristic of the spirit of the nation, but I have observed that younger trees thrive better, and in a few years catch up with, and surpass in beauty, those that were more mature at the time of planting. The younger trees are not so liable to die from replanting.

The time of transplanting varies in different climates. I consider generally that the fall of the year is the best time, when the sap has ceased to flow, while the earth is yet warm, and the consequent shock of removal is not so great as in the spring. The temperature of the earth is then much lower than the atmosphere and the roots are chilled while the stem and branches are being warmed. The practice of removing trees and plants while the earth is frozen around the roots has much to commend it, if the roots are protected from injury; but it is not sufficient to dig a hole of the size required to receive the small ball of earth around the roots of the tree to be planted. A much larger excavation should be made for this purpose, in uncongenial soils, with a layer of broken bricks and mortar rubbish placed in the bottom, and filled in with prepared soil of decayed sod or other material as the locality demands. This will insure a vigorous growth of the tree.

In making a new lawn, where there is any irregular filling, the ground should be well tamped, or soaked with water and rolled, to prevent future unequal settling, which is a frequent cause of annoyance. There should be a liberal depth of good soil to retain moisture for the roots of grass during the hot weather, though in some localities too much soil is objectionable, as it causes a rank growth, which requires constant mowing.

In refractory ground it is sometimes necessary to break up the hard pan of the existing surface before putting on the soil, and in heavy, wet clay ground it may be necessary to have tile drain subsoil, as well as surface drainage. The excavation for these drains can be filled in with either gravel, broken bricks, stone or other debris, to within a foot of the surface, and then covered with soil. A lawn that otherwise would be unfit for walking upon after heavy and continuous rains can thus speedily be made dry. Wet ground often produces moss to the detriment of the grass.

The lawn can be beautified by planting, by one who understands it, and knows what growth the various plants and trees will make, and what will be their effect in contrast, shape and color. For instance, a great variety can be produced by the planting of evergreens among deciduous trees, and the grouping of hardy foliage plants, and the display of rare, flowering and interesting shrubs and specimen trees, and the planting of high grasses, trailing roses and creepers, vines trained on trees, etc., will give a hint as to the manner in which this can be done. A judicious selection of plants is required, and artistically set out a pleasing effect is secured, that gives a constant variety, with planting that will need but little care. Where shrubs are not obtainable, or in districts where they will not live without protection, many of the hardy native trees can be used for the purpose, and if kept closely cut down, they will form a dwarf growth, and have a shrub-like effect.

Geometric flower beds for the display of masses of flowers, without the setting of green that nature always gives, have an unnatural effect and should be avoided in pure design. Large masses of the same variety of flowers are sensational and unsatisfactory, and do no service, except it be to show the producing power and skill of the horticulturist. Where it is done in formal beds, in such positions as formal beds are allowable, the flowers should be relieved by foliage plants, as nature shows us in all her flower displays.

Walks must of necessity be made of different materials in different districts. No rule can be laid down for their construction, except that, in my opinion, they should never be made of dark finished asphalt, as the

color contrasts badly with the grass. Cement concrete is also objectionable, because it *looks* hard and unnatural, and the edges are preternaturally true. A good binding gravel (or crushed stone or granite) walk, with proper foundations, is to my mind the ideal walk for a garden; its color harmonizes, it is easily weeded, regulated, rolled and kept in order; it gives the gardener a chance to make a nice edge to his turf, and when properly drained is soon dry after rain. If there is any gravel in the neighborhood, it can generally be made of the right consistency by admixture.

The line of a road should be carefully considered with regard to the scenery, the trees, and the views of the buildings to be reached, so as to create favorable impressions of the whole. The architectural effects of fine buildings have often been marred by neglect of proper consideration in this matter.

The roads for a public park should be wide according to their use, but they should be made subordinate to the park. If they fill their purpose of allowing one to drive around and through the grounds, so as to command the principal points of interest, and the views, conduct to the buildings, are gracefully curved and follow the contour of the ground, they must of necessity be in the right place.

Cutting up a park with a labyrinth of roads not only robs it of its park-like nature (a park requiring broad open spaces with long vistas), but takes away just so much of its area of grass and foliage. The roads, in showing the beauties of the park, should add to them by their graceful outline, but it is in the conformation of the ground, the trees, the planting, and the water effects, that we seek for real enjoyment.

It is only from experience that one can speak with any authority on the subject of practical road making. Having designed and executed many miles of roadway in dissimilar formations of country with varying materials, I speak from my own knowledge and experience of their construction and maintenance.

There are several systems of metaling roads used and advocated, but each case should be governed by circumstances.

I am here referring only to country roads and carriage ways for light traffic, made of the material most readily accessible and cheaply obtained, and will mention the principal things that are necessary to be observed in making a good roadway.

Assuming always that the right route is chosen, the grades are not objectionable, the width is sufficient and of right proportion, the roadbed should be formed to as true a surface and contour as the top metaling has to be, and made hard and compact. It costs no more than to do it carelessly, and insures the application of an equal thickness of wearing material, and a road made in this way with a thin layer of metaling will wear better than a thicker layer placed on unprepared ground.

Where filling has been done it should be tamped or watered, to settle and consolidate it, and should be thoroughly well rolled. This is most important, for unless the roadbed is hard and perfectly true, the top surface cannot be so, without excessive rolling and making up. The expense of renewing the metaling caused by settlement gives more annoyance and costs more than it would to form the bed properly at first. It is a common practice to leave the roadbed rough and uneven, and level up with the top dressing, but this practice cannot be too strongly deprecated, for, as a general rule, little attention is given to roads when once they are made, and the inequalities that are soon apparent increase with the passage of every vehicle.

I have generally found that each neighborhood, and ofttimes the work itself, provides some, if not all, the necessary material for a road foundation; for instance, in a clay country the clay can usually be burned in heaps and used for that purpose. It makes an excellent dry and hard foundation, but is fitted only for that, as it grinds into red mud or dust if exposed to traffic, and either gravel or stone must be obtained for the top dressing.

In a country of stone formation the stone, perhaps obtained in excavation for work, or got close at hand, can be placed over the surface in slabs, cracked by sledge hammers to fit in position, the interstices can be filled in with spawls, and the top dressing made of suitable broken stones.

In a gravel district there should be no trouble, for while bank gravel can be used for the foundation, the gravel can be screened to obtain clear stones to be used for top dressing.

A judicious admixture of bank and clean lake gravel will make a good road.

Chalk for foundations and broken flints for top dressing is another combination that can be used. They are often found in the same locality.

Furnace slag or cinders make excellent dry foundations for roads and walks.

There are few localities, however, where improvements are made in which supplies of proper road making material cannot be obtained.

The foundation material must be evenly spread and leveled and rolled, and should be as true to contour as before mentioned for the roadbed, before applying the top dressing, which should be of material that will "pack" and wear well, and not get sticky in wet weather, or grind into dust. It should be well rolled and left compact and hard, and be of sufficient thickness to prevent the wheels from ever cutting through to the foundations. This latter should never be allowed to occur, and each rut as it appears should be carefully filled in. A new road is like a new baby, it requires to be carefully watched and nursed the first year of its life. The thickness of the metaling required varies with the use to which the road is to be put, and the nature of the subsoil, but it is not often that a sufficient foundation is made.

A most important part of maintaining roadways is proper drainage. The location, grade and use of road are important factors in determining the best treatment in this respect. The general principle, however, should be to give the road a sufficient contour—not exceeding one-half inch to the foot—so that the water will run freely to the sides, and flow into ditches, either open, or with tile drain or sewer pipes laid in them and covered over, with catch basins at intervals.

The old plan of the open ditch on each side, however modified, is the simple and natural way. In building roads in ravines where there is considerable flow of water after thaws and heavy falls of rain, I have found it the only practicable way of preventing wash-outs, which would certainly occur if a covered sewer and catch basin system was adopted. It does not necessarily follow that the ditch must be on both sides all the way; a smaller gutter can be formed on one side, crossing under the road to the larger one at intervals.

Grass drives can be made by putting in a proper foundation for the roadbed, draining it, and then soiling and sowing the surface, and they can be driven on after rain without cutting the sod to any extent. They are extensively used on large estates. They serve the purpose admirably for light occasional use, there is no cost for maintenance, and there is no road apparent to mar the landscape effects.

In wet and boggy places, I have frequently prepared a roadbed with the adjacent soil, formed on thick layers of brush, laid transversely, and then metaled in the usual manner, in this way making solid hard roads, over ground that was before impassable.

ERNST HAECKEL.

FEBRUARY 16, 1894, completed the sixtieth year of the life of Ernst Haeckel, the German student and talented scientist, whose work as a pioneer has been equaled by few. He now occupies Oken's chair at Jena, and has inherited, so to speak, the old master's boldness of thought. He is one of the most zealous advocates of the Darwinian theory, and was, perhaps, the first professional man in Germany who declared for this doctrine.

He was born in 1834, in Potsdam, and studied medicine, and, in connection therewith, the natural sciences, in Wurzburg, Berlin and Vienna, and after he had completed his course he settled down in Berlin to practice his profession. But as Darwin's epoch-making works appeared one after the other, the young physician decided that his vocation lay in another direction. His studies carried him to Naples and Messina in 1859 and 1860, and in 1861 he went to Jena to teach zoology. He was called to the high school there in 1862 as an under professor, and in 1865 became a regular professor of this branch of study. He still remains true to his chair in Jena, but his teaching has sometimes been interrupted by extensive journeys. In his numerous literary works he addressed not only those who were interested in one branch of study, but all educated people (take, by way of example, his "Natürlichen Schopfungsgeschichte"—"The History of Creation"); and, furthermore, he explained his point of view in clear popular lectures delivered in almost all parts of Germany.

ERNST HAECKEL.

Although scarcely any of the modern students of natural science ranks higher as an investigator of exact details, he bases his theories less on these than on a combination of all that has been brought to light by recent research. Haeckel was, in fact, the first to point out the importance of speculative investigation in connection with the study of natural science, and to this he owes his uncommon success.

He has done much for the spread of the Darwinian theories, and has made many important corrections in them, and even those who disagree with Haeckel and consider that his ideas are hypothetical cannot deny that no similar attempt has ever been made to trace all life, animal and vegetable, back to a common origin. At present no other name is as widely associated with the theory of evolution as Haeckel's. The bold German scientist has gained many friends everywhere by his frank and open manner. The best that we can wish him is that he may long retain his present ability for thought and work; he has already done all that is necessary to make his name famous for many generations to come.

For the accompanying engraving we are indebted to the *Illustrirte Zeitung*.

THE WHISTLING TREE.—A species of acacia, which grows very abundantly in Nubia and the Soudan, is also called the "whistling tree" by the natives. Its shoots are frequently, by the agency of the larvæ of insects, distorted in shape, and swollen into a globular bladder from one to two inches in diameter. After the insect has emerged from a circular hole in the side of this swelling, the opening, played upon by the wind, becomes a musical instrument, nearly equal in sound to a sweet-toned flute.

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